
Texas Government Strategic Plan for Telecommunications Services

Telecommunications Planning Group

General Services Commission

Department of Information Resources

Comptroller of Public Accounts



October 1, 1998

Austin, Texas

Texas Government Strategic Plan for Telecommunications Services

Telecommunications Planning Group

General Services Commission

Department of Information Resources

Comptroller of Public Accounts



October 1, 1998

Austin, Texas

Acknowledgements

Telecommunications Planning Group (TPG)
Carolyn Purcell, Department of Information Resources (TPG Chair)
Ginger Salone, Comptroller of Public Accounts
Tom Treadway, General Services Commission

The TPG would like to acknowledge these and other state agency staff who assisted in this process.

Telecommunications Planning Group and Advisory Agency Staff
Charles W. Brown, Texas State Library and Archives Commission
John Deones, Texas Department of Protective and Regulatory Services
Henry Dietz, Department of Public Safety
Eddie Esquivel, Department of Information Resources
Dennis Fouty, University of Houston
David Freeland, Department of Human Services
Bill Grabo, Texas Higher Education Coordinating Board
Rhonda Hill, Telecommunications Infrastructure Fund Board
Jerry Johnson, Department of Information Resources
Roger Killingsworth, Department of Public Safety
Dale Krueger, Texas Education Agency
Walt Magnussen, Texas A&M University System
William McCaughan, Texas Tech University
Steve Parker, General Services Commission
Bob Ports, University of Texas System
Warren Ressel, Health and Human Services Commission
Bruce Schremp, General Services Commission
Rusty Seale, Department of Human Services
Nancy Vaughan, Texas Education Agency
Carol Willis, Comptroller of Public Accounts
Ken Woods, Texas State Technical College

Other Participants

Texas Association of Counties
Texas Municipal League

Copies of this publication have been distributed in compliance with the State Depository Law, and are available for public use through the Texas State Publications Depository Program at the Texas State Library and other state depository libraries.

This plan is available on-line (<http://www.state.tx.us/TPG/>).

Department of Information Resources
P.O. Box 13564, Austin, TX 78711
Tel: 512-475-4700 Fax: 512-475-4759

Contents

1. Executive Summary	1
2. Overview	5
A. Background	5
B. Scope of Plan.....	7
3. Vision.....	9
A. Mission Statement	9
B. Vision of Telecommunications in State Government.....	9
4. Current Environment	13
A. Background on Previous Telecommunications Plans	13
B. Agency Service Requirements	14
C. Status of Infrastructure.....	37
5. Analysis.....	41
A. Guiding Policies	41
B. Issues with the Existing Infrastructure	42
C. Functional Requirements of the State Infrastructure.....	45
6. Goals and Objectives	53
A. Provide Citizen Access to Government Information and Services	53
B. Provide the Platform for Access to Educational Resources	54
C. Provide Essential Network Services to Government Agencies	54
D. Consolidate Agencies' Statewide Network Requirements.....	55
E. Centralize Access to Network Services and Information.....	56

F. Facilitate the Exchange of Government Information	56
G. Provide Open Interfaces for Connectivity	57
7. Time Line for Success	59
A. Long-Term Vision for Implementation	59
B. TEX-AN 2000	60
C. Reaching the Goals	61
8. Policy Issues	63
A. Community-of-Interest Networks and the Need to Consolidate into a Single Network.....	63
B. Network Use Policy	64
C. Support for Local Entities and Statewide Services	65
D. Coordination of Access to State and Federal Funds	66
E. Agencies not Using the TEX-AN Network	67
F. Internet Address Space	68
G. Cost of the Network	70
H. Competition in Local Services	70
I. Use of the State Right-of-Way to Install Telecommunications Facilities	71
J. Network Security	72
Appendix 1. Telecommunications Planning Group Legislation	73
Appendix 2. Telecommunications Planning Group Strategic Plan Process....	77
Glossary.....	81
Notes	87

1. Executive Summary

Texas Government Strategic Plan for Telecommunications Services

The 75th Legislature required the Telecommunications Planning Group (TPG) to plan and implement a statewide telecommunications network.¹ The TPG approached this responsibility by establishing an open process that included input from agencies, the public, and the private sector. The cumulative effort is incorporated into this document, the *Texas Government Strategic Plan for Telecommunications Services* (Telecommunications Plan).

The TPG adopted the following mission statement and goals for the Telecommunications Plan.

Mission Statement

The *Texas Government Strategic Plan for Telecommunications Services* will establish the framework for a state telecommunications network that will effectively and efficiently meet the long-term requirements of state government for voice, video, and computer communications, with the goal of achieving a single, centralized telecommunications network for the state.

Goals

The Telecommunications Plan identifies the following goals in implementing a consolidated statewide infrastructure:

- Provide citizen access to government information and services
- Provide the platform for access to educational resources
- Provide essential network services to government agencies
- Consolidate agencies' statewide network requirements
- Centralize access to network services and information
- Facilitate the exchange of government information
- Provide open interfaces for connectivity

Based on an analysis of the current state government requirements and the existing technological environment, the TPG has proposed a fiber-based infrastructure to meet future state government needs. The TPG has not specified whether the solution should be state-owned, leased, or outsourced; but rather, has delegated the implementation aspects of the network to the

General Services Commission (GSC), the managing agency of the state telecommunications network, TEX-AN.

Arriving at a single, consolidated statewide network involves two areas of service:

- Consolidation of the state transmission requirements (the bandwidth, or circuit capacity, needed to carry the data, video, and voice services) on a single, statewide backbone; and
- Provision of network connectivity (the actual connection from the users to a statewide backbone infrastructure) for the user locations on a statewide basis.

The consolidation of the transmission aspects is addressed within this plan. Providing network connectivity for all agency locations can be addressed on the network; however, this raises issues regarding the impact on individual agency needs and on the security and privacy of information on the network.

Though the TPG accepts the responsibility of implementing a consolidated transmission and connectivity network, the following issues were raised during the planning process:

- Diverse agency needs complicate the process of consolidating all agencies into a single data network. Agency requirements can be grouped into community-of-interest networks. As an example, interests of the criminal justice systems and health and human services areas do not coincide with the needs of the education areas in regards to security, privacy issues, and other requirements.
- There is a large investment in the existing state agency networks, which were implemented to meet specific needs. Migration of these networks to a single consolidated network should be based on voluntary compliance, if at all, and over several years. This would enable agencies to plan for future migration issues and allow the state to fully realize previous investments. Central support issues could also be addressed properly.
- The state infrastructure increasingly supports local government access to the state and national networks (e.g., the Internet), especially to remote regions where there are no other willing service providers. This growth in service compounds the issues regarding diverse interests (e.g., K-12 education on the same network as sensitive criminal justice transactions) and also increases the support and management required to operate the network. GSC will need to address these central management and

operational issues as the network continues to expand in serving rural and remote areas.

- The state network cannot currently support nongovernmental institutions. This is a factor in providing connectivity for some projects (telemedicine and services to rural areas) and may affect future electronic commerce endeavors.

This document addresses the direction of the state network and issues the state must be aware of in the coming years. Implementation of the next TEX-AN network design will begin in fiscal year 1999 and the information in this document will be the basis for the initial design work.

2. Overview

Texas Government Strategic Plan for Telecommunications Services

A. Background

The Telecommunications Planning Group (TPG) was originally created by the 72nd Texas Legislature in 1991.² The legislation was based on statewide telecommunications issues and recommendations presented in a Texas Performance Review report by the Office of the Comptroller of Public Accounts (CPA).³ The legislation made the Department of Information Resources (DIR) jointly responsible with the CPA and the General Services Commission (GSC) for planning and implementing a statewide telecommunications network.

The TPG established the functional requirements for the TEX-AN III network in 1993 and published the *Texas Telecommunications Strategic Plan* in 1994.⁴

Current Legislative Requirements

The Telecommunications Planning Group was reconstituted by the 75th Texas Legislature in 1997 (full text of the TPG legislation is included in Appendix 1). Additionally, the Legislature named several state agencies as Advisory Agencies to the TPG. The TPG was legislatively mandated to:

- Develop a plan for a state telecommunications network with the goal of achieving a single, centralized telecommunications network for state government.
- Collect and manage configuration information about existing and planned telecommunications networks throughout state government.
- Establish plans and policies for a system of telecommunications services operated by GSC.
- Develop a statewide operating plan for all state agencies implementing the statewide network and including technical specifications that are binding on GSC.

- Develop functional requirements for a statewide system of telecommunications services.
- Report to the Legislature biennially on the status of implementing the strategic plan.

This document is the strategic plan for the statewide telecommunications network. The TPG will update the Legislature every biennium on the progress toward the plan's implementation.

Process for Completing Plan

The TPG formally adopted a process to complete the telecommunications strategic plan. The goal was to open the process for input and comments from the public, vendors, and agencies not directly involved in the TPG. The main steps of the process were to:

- Complete an outline of the Telecommunications Plan for the first meeting with the Advisory Agencies.
- Develop a TPG web site. The web site (<http://www.state.tx.us/TPG>) is used to inform the agencies and the public on information from the TPG. All TPG information, staff and TPG meeting minutes, and edited draft documents, were posted on the web site. Additionally, announcements of TPG meetings and agendas were included.
- Create a mailing list to provide for the exchange of comments and information related to the TPG. The mailing list is open to the public.
- Establish a schedule depicting time frames for meeting with the Advisory Agencies before each TPG meeting. Additional meetings were called as needed to review task force findings, review draft documents, and handle other special cases. The goal was to reduce the actual number of required meetings and to perform most of the work through electronic means.
- Distribute the draft outline for the Telecommunications Plan and call for volunteers to complete the sections. Contributors to the plan are listed in the Acknowledgments.
- Meet on a quarterly basis to be updated on the status of the Telecommunications Plan and other TPG issues.

The TPG formally adopted the contents and final plan on June 26, 1998. Additional detail on the process and methodology the TPG used to complete the Telecommunications Plan is included in Appendix 2.

B. Scope of Plan

The Telecommunications Plan addresses issues related to TEX-AN, the state network managed and operated by GSC, and to the services provided on TEX-AN for agencies and universities. Additionally, the Telecommunications Plan addresses the requirements for building a statewide telecommunications infrastructure that will support state government needs for a consolidated network for the future.

The various sections of the document address the following objectives:

- Establish a vision for state government's telecommunications infrastructure that meets the state's future and ongoing needs, is planned in conjunction with other state information resources initiatives and goals, and addresses the legislative mandates.
- Identify the current telecommunications environment that will affect the state telecommunications network.
- Analyze the telecommunications issues, requirements, and technologies affecting the implementation of the statewide network.
- Define the goals, objectives, and functional requirements for the future statewide network and the time frame for implementing the objectives.
- Identify issues that need resolution for the state to build a consolidated network.

The Telecommunications Plan strategically directs the state toward accomplishing these goals. It describes the framework that will lead to agencies using the statewide network willingly, which will lead to a consolidation of most telecommunications requirements. The Telecommunications Plan does not address operational issues that are the directive of GSC or public infrastructure issues that are regulated by the Public Utility Council, the Federal Communications Commission, or other regulatory bodies. However, as appropriate, recommendations for public policy and legislation are identified in the document.

Common Terminology

In order to gain a common ground in discussions about the state telecommunications infrastructure, the following information is provided to describe the intent and applicability of this document.

The state currently has a statewide telecommunications infrastructure, TEX-AN; however it does not fulfill the current legislative requirements. In order to achieve a consolidated statewide telecommunications network, the state must address and support the following:

- *Provision of telecommunications bandwidth to support telecommunications applications*—This includes raw bandwidth such as T1 and T3 circuits to support the statewide networks. The TEX-AN network currently provides this bandwidth to support state data, voice, and video applications. A series of contracts provided by GSC allows for the bulk acquisition of bandwidth to reduce overall state costs. All agencies are required to use the TEX-AN infrastructure when procuring intercity telecommunications services.
- *Statewide network connectivity*—Voice applications are currently delivered through TEX-AN by the use of local telephone offices and a contract with a carrier for the use of central office switches and multiplexers located centrally around the state. GSC currently supports data network connectivity through a series of regional hubs; however, several other agencies also have established regional hubs for connectivity. Instead of locating various agency hubs in the same regions, a consolidated statewide infrastructure for data would connect all agencies to a single backbone hub infrastructure, reducing costs for hubs and duplicate equipment statewide.
- *Central support and information center*—Services provided for the statewide infrastructure should be centralized. These services include network management and operations, ordering, troubleshooting, contract management, service level support, billing, information requests, and other similar functions. The agency that manages and operates the statewide infrastructure would provide the central information center.

As mentioned previously, the state currently operates a consolidated statewide infrastructure, in that all telecommunications bandwidth is purchased for a single network. However, all state agencies' data and video networks have not been consolidated into a single system. The GSC data network is currently offered to agencies and local government as a statewide network to support access to state systems and the Internet. Issues with requiring agencies to use a centralized network managed and operated by a centralized support center are the scope of this strategic plan.

3. Vision

Texas Government Strategic Plan for Telecommunications Services

A. Mission Statement

The Telecommunications Planning Group adopted the legislative mandate as the mission statement for the Telecommunications Plan.

The Texas Government Strategic Plan for Telecommunications Services will establish the framework for a state telecommunications network that will effectively and efficiently meet the long-term requirements of state government for voice, video, and computer communications, with the goal of achieving a single, centralized telecommunications network for the state.

The framework described in this document addresses the long-term telecommunications requirements of the state. This time frame represents the ten-year period (1998–2008) described in the 1997 State Strategic Plan for Information Resources Management.⁵ The State Strategic Plan identifies the need to develop and implement a statewide information infrastructure, with the telecommunications infrastructure being a key in accomplishing this goal.

B. Vision of Telecommunications in State Government

State government will be supported by a robust telecommunications infrastructure managed and operated by the state. The public will have access to state information through an infrastructure supporting the dissemination of this information. Bandwidth will not be a bottleneck in implementing applications and services for citizens. Communication links will interlace the state like an electronic mesh, catching all information and delivering it to appropriate access points across the state.

This vision establishes where the state telecommunications network will be in the next ten-year period. The following areas are targeted for implementation.

Access—A statewide network where any agency can connect to, receive, and provide access to information for all citizens, agencies, and businesses.

The statewide network will provide access by the public to the various statewide databases and applications maintained by agencies and universities.

The network will provide the means for agencies to distribute information by providing secure links with sufficient speed and bandwidth to exchange information among the state agencies and provide easy access to the general public.

Central Management—A centralized information and operations center that agencies can call and be provided a one-stop shopping environment.

The statewide infrastructure will be supported by a one-stop support management system. Agencies will be able to connect, place orders, and monitor the status of problems through a single contact point in the network management center. The network infrastructure will be supported and managed through central monitoring systems that can detail and report problems before the users are aware of them. A technical team will support the agencies' planning requirements and agencies need only supply the functional needs in order to receive the required telecommunications services.

Electronic Commerce—A statewide network supporting the exchange of business transactions in a secure and confidential method.

The network will support intelligent applications that monitor access to the infrastructure and, if necessary, will encrypt data to ensure the safe and secure transmission of transactions. Electronic procurements and financial settlements with private industry will be the status quo.

Open Platform—A statewide network that is open and interoperable with vendor products.

The state continues to implement platforms that will promote open systems and interoperability. Vendor products conforming to industry and international standards will find a market in the statewide infrastructure. Agencies will have a wealth of choices in procuring products that will interconnect and operate on the network. A common set of standards will simplify the design of systems required for agencies to communicate with each other.

Self-Sustainment—A statewide network that supports itself by providing needed services to agencies and political subdivisions.

The state telecommunications network will continue to be self-sustaining by recovering its costs from the services provided to its customers. Funds appropriated to agencies will pay for the network as the available services continue to expand and the quality of the network ensures reliability.

Voluntary Compliance—A statewide network that presents agencies reasons for voluntary compliance with state policy on use of the network; thus, not giving agencies incentive to shop around for better deals.

Agencies should have no need to request waivers and exemptions from the use of the state network. The costs, services, and reliability of the network will ensure customer satisfaction and will mute the mandatory requirement that agencies use the network. A centrally managed network will provide statewide access and connectivity so that agencies will not have that responsibility. Agencies will connect to the nearest access point to the statewide enterprise managed by GSC.

4. Current Environment

Texas Government Strategic Plan for Telecommunications Services

The state is in the process of reengineering the statewide telecommunications network and renewing the services to support the network. In doing so, state telecommunications planners review information from various sources, including previous plans and customer (agency, university, local government) requirements. The needs of the state have grown and changed since the last network upgrade and the network infrastructure must adapt to serve these requirements.

The 1993 State Strategic Plan for Information Resources Management⁶ (State Strategic Plan) states that “An emphasis on using information resources to provide better and new services to the individual and corporate citizens is emerging throughout state government.” Subsequent versions of the State Strategic Plan⁷ indicate that a “coordinated communications infrastructure is necessary to leverage interagency endeavors and to provide services in an efficient manner.” In order to provide the services and information, a communications infrastructure must be in place to disseminate and allow for access to the information. This section describes the current telecommunications environment in the state, along with issues affecting state and local government requirements.

A. Background on Previous Telecommunications Plans

The Telecommunications Planning Group (TPG), in coordination with state agencies and universities, has published previous plans to assist the state in planning for its telecommunication requirements. In order to build on previous accomplishments, a brief overview of these plans is presented.

State Network Plan (1991)

In 1991, the TPG developed the *State Network Plan* to help set direction for the replacement of the TEX-AN II network contracts and services.⁸ The plan identified the problem with the diverse agency and university networks and telecommunication requirements that created difficulties in the sharing of capacity and exchange of information, and added to the state’s overall

transmission costs. The plan set as a goal the development of a unified state network, based on open standards and concepts, that would support the state's connectivity needs. The first step in this process was completed with the award of the TEX-AN III contract for services and the development of the Capitol FDDI ring that provided for the inter-exchange of information.

Texas Telecommunications Strategic Plan (1994)

In 1994, telecommunications issues were widely discussed at the national and state regulatory level. Deregulation of the local exchange telecommunications market was the legislative telecommunications issue for the time period. The 1994 *Texas Telecommunications Strategic Plan* tried to address the issue as it affected the state government.⁹ The plan also took a broader view of the state clientele to include local government and citizen access.

The plan's goal was to promote a telecommunications infrastructure providing statewide broadband, switched services at reasonable costs. The goal directed that these services be available not only to state government, but to local entities and the public as well. The plan promoted the accomplishment of these goals through legislative recommendations and the consolidation of telecommunications service groups within state government.

Since the publication of the plan, the Legislature has deregulated the state local exchange environment, funding has been made available for schools and libraries, and agencies have moved towards enhanced infrastructures, including extensive use of the Internet, to provide access to information. Additionally, the DIR and GSC telecommunications service bureaus were consolidated at GSC.

As indicated in this plan's mission statement and future vision, the state will continue to build on work previously accomplished and on goals and recommendations that still apply today.

B. Agency Service Requirements

Agency requirements can be identified within different service groups based on legislative mandates or community-of-interest areas. These were identified in the 1994 telecommunications plan and are further refined in the following sections. Many government services are interrelated by function or legislative mandates. The needs of these service areas are intertwined within the functional groups and sometimes have little to do with the other community-of-interest areas. However, all groups present a need for additional

functionality, bandwidth, and support, and address how telecommunications costs continue to be a barrier to provision of services.

Citizen Access

Citizen access to government information is supported through legislative initiatives addressing access to government files. Among the pertinent acts are:

- The Texas Open Meetings Act requires all governmental bodies to deliberate in public, unless a closed or executive session is expressly authorized.¹⁰
- The Public Information Act specifies that the documents or records of a state agency are open to the public, unless there is an explicit provision to keep a particular item confidential.¹¹ One of the requirements of laws governing the management of state and local government records is that records be retained for minimum periods of time, as determined by the Texas State Library and Archives Commission, before they are eligible for destruction.
- Senate Bill 897 of the 75th Legislature established the Records Management Interagency Coordinating Council (RMICC) and directed that the General Services Commission (GSC) and the Public Utility Commission publish an alphabetical listing of government services by subject matter in state and public phone listings. The bill tasked RMICC to study requirements, policies, and standards for electronic records. The bill also tasks the Council to consider the feasibility of establishing a searchable database to contain state agency records in electronic formats.¹²

The intent of these acts is that the information collected and generated by governmental bodies be made available to citizens unless there are explicit actions to restrict the access. The 75th Legislature stepped beyond the rules for making information available and began addressing *how* to make the state information available, such as through the actions discussed above. The question, however, is the fiscal logistics of achieving these public policy goals.

The current Public Information Act doesn't address cost recovery of the implementation of the policy, and in recent funding cycles agencies have been discouraged from seeking additional appropriations for its implementation. Public access initiatives have generally been absorbed by existing budgets; increased demands for access are becoming fiscal burdens. Operational conflicts arise when agencies must choose between allocating staff to support mission-critical processing functions and public access initiatives.

The following cost issues need to be addressed in implementing a broad policy supporting public access to government information over the Internet:

- *Infrastructure*—An infrastructure providing adequate Internet connections, hardware, software, and other network resources must be implemented to support the delivery of information through this medium. Infrastructure costs are generally commensurate with the volume of data to be made accessible.
- *Data Conversion*—Production data may include highly sensitive information, which is not subject to public disclosure. Live production data may need to be redacted and stored separately for public access, for both security and cost reasons. Also, there may be portions of an agency's information that are not of sufficient interest to warrant instant Internet accessibility.
- *Ongoing Operations*—Operational costs include refreshing data on a periodic basis, hardware and software maintenance, network access charges, and refreshing the technology when the demand outstrips capacity and service levels decline.

Privacy and confidentiality of information collected or generated in many systems can be a critical issue, but the technology for addressing these concerns is improving rapidly. In a few years, digital signatures, secure financial transactions, and inexpensive encryption processes will permit the exchange of private and confidential information as well as public information over the same piece of copper.

State agencies are becoming more proactive in providing electronic access to their information. The Texas Legislature has provided a number of clear indications that it wants more, not less, access to government information for the average Texan. New technologies are providing the processes and procedures to allow the integration of public and private, or confidential, information over the same system. If state agencies do not begin to move voluntarily towards a consolidated network it may be mandated upon the agencies. The lack of some progress towards more open and flexible electronic access to government information may result in a loss of the current flexibility to use a number of media to produce government information. The fact that the 75th Legislature continued the Telecommunications Planning Group appears to be a signal to develop plans for how state agencies are going to improve the state processes for communications and how these are going to be more open to Texans.

Electronic access to Texas state government information has begun. The subject “Texas State Government” is a major topic heading of the Texas State Electronic Library (TSEL). This web site (<http://link.tsl.state.tx.us>) provides centralized access to electronic information from or about all 269 state agencies, including budget and expenditures, rules, statutes, and information about publications and archived records; and provides a keyword index to the front page of the agency web site, if any. Over two-thirds of the agencies now have web sites.

Education

Kindergarten through 12th Grade (K–12)

The first *Long-Range Plan for Technology* for K–12 education, adopted in 1988, provided for a number of statewide initiatives to enhance the use of technology in education.¹³ The *Long-Range Plan for Technology 1996–2010* builds on the first plan and focuses on four integral areas: Teaching and Learning, Educator Preparation and Development, Administration and Support, and Infrastructure for Technology.¹⁴ Recommendations in the plan are directed to the Texas Education Agency (TEA), Regional Education Service Centers (RESN), local school districts, communities, the Higher Education Coordinating Board, the State Board for Educator Certification, institutions of higher education, other state agencies, and the private sector.

The Commissioner’s Access Initiative outlines strategies for implementation of recommendations in the plan. Under the Commissioner’s Access Initiative, various telecommunications initiatives within TEA are merging into a single, integrated telecommunications system referred to as the Texas Education Telecommunications Network (TETN).

TETN is a statewide transport environment co-managed by the Offices of Instructional Technology and Information Systems. TETN supports the interactive transfer of audio, video, and data between TEA, the 20 Regional Education Service Centers, the school districts, individual campuses, and other public institutions.

Elements of TETN include:

- Dedicated T1 circuits providing live videoconferencing and data transfers between TEA and the RESNs, 24 hours per day. TETN is being expanded to provide enhanced videoconferencing and data sharing interconnectivity.

- The Texas School Telecommunications Access Resource (T-STAR) television receive-only (TVRO) satellite network, including broadcast capability to over 1,000 T-STAR TVRO satellite sites and the T-STAR Studio B videoconferencing facility. Expansion of T-STAR included modification of the T-STAR uplink signal to digital, and enhancement of satellite downlink capabilities at RESCs and school districts to receive digital as well as analog satellite broadcasts.
- Access to the Internet for all Texas educators from the workplace; access provided through resources at TEA, the RESCs, school districts, and individual campuses.
- E-mail for Texas educators; provided through resources at TEA, the RESCs, school districts, and individual campuses; master directory maintained at TEA.
- Establishment of a TEA presence on the Internet; a TEA web site designed to enhance the distribution and access of data/information.
- Development of an infrastructure for accessing and distributing sensitive data.

The objectives of TETN are to provide:

- An integrated telecommunications resource to access administrative and instructional content
- Simple, fast customer access to useful, high-quality data, services, and products

The guiding principles behind the development of TETN are to:

- Provide equity of access to the classroom
- Encourage school-based, as opposed to home-based, access
- Show respect for diversity
- Focus on the have-nots
- Think statewide; implement through regional and local partnerships
- Build on success; enhance for the future

Through TETN, teachers, students, superintendents, parents, legislators, and business leaders will have immediate access to tools, products, data, and information they need to make decisions, to educate, to plan, and to learn. Those tools, products, and data include initiatives in the following areas.

Information Access

- Enterprise Information Planning Project—to develop and implement the enterprise information architecture

- Access to PEIMS (Public Education Information Management System) submission materials—designed to promote ease of districts' data submission
- Educator community—a forum for teachers to share ideas
- Ask TED—the Texas Education Directory on the TEA web site

Business Applications and Educational Content

- Integrated Funds Management Project—automated system to process grants, entitlements, applications, and approvals for federally funded programs that are formula-based
- Data Warehouse Phase I—pilot phase of Data Warehouse initiative
- Data Warehouse Phase II—planned deliverables for accessing the Data Warehouse
- GED—a system to provide Internet access to student records via secure connection

Educational Content

- Centers for Educator Development—resources for implementation of the Texas Essential Knowledge and Skills
- START—Sharing Technology Applications Resources with Teachers
- Texas Library Connection, which includes:
 - Database of holdings in Texas school libraries
 - Britannica Online
 - Access to more than 100 nationally recognized publications, including the New York Times and Wall Street Journal, as well as Texas periodicals and newspapers, through UMI ProQuest Direct
- T-STAR broadcasts to more than 1,000 T-STAR TVRO satellite sites
- Satellite broadcasts from distance learning providers
- T-STAR Information and Training Center

Challenges to the implementation of technology include, but are not limited to:

- School facilities must be modified to handle electrical and connectivity needs as well as increased technology.

- High administration and support costs have significant impact on school budgets.
- Cost of training needs to be addressed. Staff development on the integration of technology into teaching and learning as well as instruction on how to use the technologies is in constant demand. The number of professional development days is limited and there are significant competing needs.
- Local support for technology within the school system is limited.
- Coordination of planning is essential between K–12, higher education, and workforce development.

Additionally, the following trends affect the telecommunications needs of K–12 Education:

- TEA's *Long-Range Plan for Technology* states specific objectives for the use of technology in schools. The demand for access to the Internet, as well as to other telecommunications services such as videoconferencing for distance learning, will continue to rise as districts move closer to achieving the goals set out in that plan.
- The continued expansion of TIFB grants—both in scope of coverage and in type of resource provided—and the continuing availability of federal technology grants will also drive increases in the demand for integrated telecommunications services.
- The continued expansion of regional networks and cooperatives, both driven by RESCs and by local communities, will continue to drive demand for service. In addition, the creation of such regional and community networks makes it imperative that a robust statewide backbone network be provided to easily interconnect these regional/community networks and to deliver the integrated voice, video, and data services that many regional networks already provide.
- The school population in Texas will continue to grow; the estimated increase in the number of new students in the K–12 system each year is 70,000.
- Major studies commissioned by the Legislature during the current interim address topics that could create even more demand than that generated by the schools themselves. These studies address whether or not PCs and Internet access should be provided to each teacher in his or her home.

- In addition, the State Board of Education has initiated a vigorous discussion of the use of laptop computers to replace the current printed textbooks. Any movement to do this, or even to provide textbook updates via telecommunications, could result in a significant increase in the need for bandwidth to the local site.
- Continuing pressure to achieve equity within the school system makes it imperative that the state addresses the “last mile” issue for small and rural communities. This pressure also makes it imperative that the same quality of service and the same integration of voice, video, and data service be available to all communities within the state.
- The continuing pressure to improve student achievement, coupled with changes in the Recommended High School Program, will continue to drive increases in the demand for distance learning resources to all parts of the state, particularly remote and rural communities. Distance learning will require high-quality videoconferencing and continued increases in the bandwidth required at the local level.
- The availability of funding directed to technology initiatives is growing. The Technology Literacy Challenge Fund will provide over \$150 million to Texas schools between 1997–2002. The Telecommunications Infrastructure Fund will provide \$75 million for K–12 each year for 10 years and the Universal Service Fund is estimated to provide approximately \$150 million in discounts each year to Texas schools through the Education Rate (E-Rate) Program. These increased resources are driving new demand for telecommunications services.

The combined effect of these trends will be continued increases in the demand for high-quality, high-bandwidth telecommunications services to every community in the state.

Higher Education

Higher education in the State of Texas includes private universities, independent colleges, community colleges, technical colleges, public universities, and junior colleges. According to the Texas Higher Education Coordinating Board statistical survey, there were over 905,000 students registered at these institutions in 1995. In fiscal year 1995, public universities granted over 73,000 degrees. These institutions had over 24,000 faculty members, managed close to 100 million square feet of space, and were granted approximately \$4.9 billion in state appropriations.

While many of the telecommunications needs of higher education are not unlike those of other state agencies, there are a few differences. These differences are driven by the mission of higher education, which includes education for all, research for many of the institutions, and service to the State of Texas.

Education

Many of the telecommunications needs of higher education in fulfillment of the educational responsibility are met through existing telecommunications services. The basic need for telephone services are well met through the existence of the TEX-AN network and services provided by the local service providers. Reduced rates for circuits, established by House Bill 2128, have facilitated the connections between campuses for commodity Internet traffic and distance education. Needs that have yet to be fully addressed include:

- *Dial-up network access for students using distance education*—Many higher education programs depend heavily upon the Internet. Applications include on-line registration, assignments made available over the network, and students communicating with each other and the professor via list servers, to name a few. Many of the institutions have created modem pools to support the needs of the local students, but there is no cost-effective method of supporting the same types of services for students learning at a distance. While the commodity Internet may be one solution, it is not certain that reliable service providers are available across the state.
- *High-speed, reliable Internet access*—Access to the national Internet has been provided by the Texas Higher Education Network (THEnet, managed by the University of Texas and Texas A&M University) and Sesquinet (managed by Rice University until December 1997). While the capabilities of these networks have been growing, it is not certain that they have been keeping pace with the growth in demands placed upon the network. There is a need for a more formal mechanism to forecast and fund this growth. In addition to the growth of the Internet, reliability is also a critical factor. Each institution or system currently creates its own intranet with little coordination among them. Distance education is built upon collaborative initiatives between institutions. These initiatives require a reliable Internet to thrive. One method of increasing the reliability between these intranets is through a linking of the management systems currently in place by each institution to manage its own networks.

Research

The needs of the research community are driven by needs that are, in many ways, different from other state agencies. Much of this research is driven by high-end computational resources (supercomputers) that are not cost-effective

to duplicate across multiple institutions. The initial capital cost of acquisition and the continued cost of operation place these supercomputers well beyond the means of most organizations. There is ability for institutions to share these resources if the telecommunications infrastructure is in place to support such sharing. These resources require two attributes:

- *High bandwidth*—Typically the input into supercomputers is extremely large data sets and the output can include animation which, in and of itself, is extremely bandwidth-intensive. A further complication is that research often involves multiple iterations of the same computer jobs, which means that a one-time trip to the supercomputer site is not feasible. When these types of jobs are running they will often consume OC-1 (52 million bps) or OC-3 (155 million bps) for a short period of time. Most of these required links exceed the capabilities of the existing TEX-AN network.
- *Quality of Service*—Along with the high bandwidth requirement is the need to be able to reserve a portion of the Internet bandwidth on an as-needed basis. An analogy is the U.S. Postal Service. For the most part, first class mail is sufficient in the delivery of material, but there are times when the added expense of next-day mail is warranted. In the future, more and more applications will require such a delivery guarantee, commonly referred to as Quality of Service (QOS). Neither the current Internet nor the State of Texas backbone can offer this QOS. As the networks grow and contention becomes more of a problem, a network resource scheduling system will be required. Such a system is not currently available, but it is a major research topic for both the Internet II and the vBNS projects as currently funded by the National Science Foundation and a number of large research institutions.

Service to the State of Texas

This is an area where, rather than the state higher education institutions having needs beyond those of other state agencies, they are able to help support the needs of other state agencies and the citizens of the State of Texas. The result of the ability of higher education to meet its telecommunications needs in the areas of education and research have led to some inherent advantages that could be leveraged by the state:

- *Technology assessment*—TCP/IP and the Internet itself were born in the research labs of universities in the early 1970s and universities lead most of the advanced network research initiative today. Under the current model, many of these institutions are early adopters of the technology. But this knowledge is rarely transferred to other state agencies. One potential method of facilitating this information transfer is through the formal

establishment of a technology assessment center within one or more of the research institutions. Funded through legislation, the charter of the center(s) would be to assist other state agencies in the implementation of their telecommunications infrastructure. The potential cost savings to the State of Texas would be immense.

- *Access to grant monies for circuits and telecommunications equipment*—Higher education has long been the primary recipient of grant funds at the local, state, national, and international level. This external funding has been one of the major reasons that these institutions have been able to embark upon potentially risky networking solutions. While this has worked to the benefit of the higher education institutions, it has not been leveraged by other state agencies. Again, a technology assessment center could facilitate the sharing of information through the grant process to other agencies.
- *Access to some of the sharpest technical minds in the country*—Today's graduate students are tomorrow's industry leaders. Much of the research required to facilitate the telecommunications infrastructure needed by the State of Texas could be funded as research accomplished in pursuit of an advanced degree. Again, higher education has always relied upon such support from graduate students, but other state agencies rarely leverage these resources.

An issue related to higher education that has led to inefficiencies in the creation of networks is the inability to easily establish relationships between the public and private sectors. While this is an issue in all of higher education, it is more prevalent in the area of medical education. All universities that have a college of medicine, nursing school, or other medicine-related field must have a relationship with an organization that supports the practical part of the educational process. While some universities choose to build their own hospitals, an extremely expensive proposition, others choose to contract such services from a private institution. The doctors on staff are often professors for state universities as well as doctors for private hospitals. This often results in the creation of two separate networks, one to support the public sector applications and one to support the private sector applications.

This separation will become more of an issue as the universities venture more into the remote delivery of medical services, or telemedicine. It will be further augmented as the role of higher education shifts from the traditional student (18 to 22 years old) to support continuing or lifelong learning. Expectations are that much of this education is to be delivered to the workplace. Again, the creation of public networks to support education and separate corporate networks to support the needs of the private sector will become a limiting factor in the delivery of educational services. There should be legislation

supporting such private/public sharing of resources when done in direct support of one of the missions of higher education.

Community and Technical Colleges

In fiscal year 1997, community and technical colleges (colleges) in Texas enrolled 420,154 students, or approximately 44.7% of all Texas students enrolled in higher education that year. In many regions, these institutions serve as the hub for Internet access to rural communities and provide access to opportunities for distance learning through interactive video. In addition, several colleges will offer access to the Western Governors University project in the future.

Through existing telecommunications services, the TEX-AN network has assisted in meeting the telecommunications needs of the community and technical colleges in fulfillment of their educational responsibilities. The introduction in 1995 of reductions in T1 and DS3 rates due to deregulated intrastate tariffs has generated a significant expansion in the demand for high bandwidth telecommunications circuits.¹⁵ This has facilitated connections between campuses for commodity Internet traffic and interactive video distance education. In addition, colleges in Texas continue to grow as focal points for regional educational, community development, and economic development telecommunications efforts. Throughout the early phases of this growth and due to limitations of the local telephone companies, the TEX-AN network has sometimes been pressed to provide sufficient bandwidth and services in some rural regions.

College requirements for TEX-AN include:

- Colleges require more than raw bandwidth to meet current educational requirements. Colleges require a dependable, sole-source provider of voice, video, and data services in rural areas. There are still some rural locations where the TEX-AN network provides bandwidth without providing hub connectivity to the Internet or VidNet.
- Colleges require a significant increase in the availability and dependability of TEX-AN bandwidth in rural East and West Texas. Traditionally, these regions have been substantially underserved when telecommunications plans have been drafted. If these regions are to keep pace with the rest of the state educational infrastructure development, colleges will need to have a voice in the future planning of critical network aspects for these regions.

Other areas of concern, not involving the statewide infrastructure, include:

- Limited technical support is available to assist rural areas in deploying and supporting their networks. Though the concern extends beyond the backbone infrastructure, these issues substantially inhibit efforts to create and maintain a statewide network of regional networks.
- Currently no central authority is in place to assist colleges in developing statewide connectivity plans. A statewide standard is needed to advance the availability and use of telecommunications technology in the delivery of educational opportunities in a fully compatible manner. Currently, numerous regional networks exist, developed independently of each other, with some inability to interconnect or exchange information. There has been little statewide effort to ensure compatibility of college networks or to plan for the long-term technical and financial sustainability of the enterprise-wide area networks being created. A substantial amount of money is being expended annually at present to create isolated, unconnected, and in many cases, unsustainable and incompatible network solutions.

Law Enforcement and Criminal Justice

Criminal justice and state law enforcement telecommunications requirements have a huge impact on the statewide infrastructure. The Texas criminal justice system includes three general areas:

- State law enforcement, including the Department of Public Safety (DPS) and local law enforcement (police and sheriff departments);
- The state incarceration process, which includes the state jails and penitentiaries managed by the Texas Department of Criminal Justice (TDCJ); and
- The court system, including the state justice system, and county and district courts.

Currently, approximately 1,300 sites are connected to the DPS Texas Law Enforcement Telecommunications System (TLETS) and close to 300 sites are part of the TDCJ network.

Growing concern over the criminal justice and law enforcement systems has led to more scrutiny of their operations and has showcased the need to upgrade the telecommunications infrastructure, in order to better serve the citizens of Texas. The Legislature has funded various initiatives to meet the

information needs of these agencies, including the following three major initiatives currently underway:

- DPS has been funded to upgrade the Texas Law Enforcement Telecommunications System to meet the FBI National Crime Information Center (NCIC) requirements and to enhance TLETS' support of local law enforcement communications needs. The NCIC requirements include higher data rates on digital transmission links, such as the capability of transmitting digitized images.
- TDCJ is currently reengineering its information resources environment, including the computer databases and applications.
- The courts were funded approximately \$5 million this biennium to begin building a court infrastructure for the exchange of documents and court e-mail, and to provide access to the Internet. The funding will include installation of workstations, LANs, and other network components in some of the courts. Additional funding may be made available in future years, as recommended in a report by the Texas Commission on Judicial Efficiency.¹⁶

These enhancements address information infrastructure concerns required to support the criminal justice system into the 21st century. In general, each of these segments requires a high-speed digital infrastructure that can support digitized images and exchange information readily among the component entities. Currently lacking is the capability for local law enforcement units to use a state infrastructure for the exchange of local information. The TLETS enhancement project and the courts' project, administered by the Office of Courts Administration (OCA), are addressing some of these needs.

Local entities (police and sheriff departments, and county and district courts, among others) are increasingly looking at their state counterparts for direction in setting statewide standards and direction in information technology. This includes a statewide infrastructure to accomplish more than accessing central state files. On the law enforcement side this includes:

- Bandwidth to support digitized images and file exchange
- Local exchange of information, bypassing a centralized system
- Standardized network connections in order to facilitate interoperability
- Internet access, as permitted by security aspects of the network
- Statewide e-mail for local entities to exchange up-to-date data
- Weather and news broadcast updates

The Judicial Committee on Internet Technology (JCIT) is addressing Texas judiciary requirements. JCIT has been tasked by the 75th Legislature to guide

the judiciary forward in technology and connectivity. The JCIT is working with OCA in finding solutions to one of the major hurdles in providing technology advancement in the courts.

The present judiciary system encompasses 16 high courts, 1,450 lower courts, and 900 justices of the peace. The JCIT and the OCA are seeking means to connect these entities over the Internet. With this connectivity, data sharing and collections, communications, and overall advancement of judicial technology can occur on a timely basis.

The OCA has begun this project with a judicial server established in cooperation with the State Law Library in Austin, Texas. Funding is not available for a dedicated judicial system throughout the state. As a result, the need dictates the use of a pre-existing network through either interagency contract or third-party contracting.

The security aspects of law enforcement curtail, to some extent, the use of a single network to serve all the functions, such as Internet access, required by all law and criminal justice components. Additionally, new implementations in satellite technology offer the opportunity to reduce statewide costs for existing networks. These considerations must be included in defining the requirements of a statewide infrastructure.

General Government

The executive and administrative responsibility of state government, which includes regulatory, oversight, and administrative functions, is referred to as general government. Communication is a fundamental and indispensable activity of general government. Efficient electronic communications between the various branches of government and their constituents, clients, and customers continues to increase in both volume and importance. State government must take advantage of enhanced telecommunications technology. By doing so, Texas state government can offer critical services when and where they are needed, regardless of the proximity to Austin.

The state's telecommunications networks tie together educational institutions ranging from public schools and colleges to specialized learning and research centers. State government must now be prepared to extend these networks and to offer easier access to information. This will involve new avenues for data exchange between agencies, as well as new opportunities to use and find value in collected information.

The following basic elements must be assessed when considering the future requirements of general government in a Texas telecommunications infrastructure.

- *Network Bandwidth*—Network performance is directly related to bandwidth. State agencies need affordable access to the larger bandwidth services available now. They also must plan and provide for access to future expanded bandwidth services.
- *Fiber-Optic Technology*—This technology holds the promise of tremendously increased bandwidth, which will provide for the more efficient transmission of digitized voice, data, and images over the lines. Advanced multiplexing schemes allow multiple data transmissions to share the same network lines. Agencies that haven't converted from analog to digital circuit technology are now making the conversion to take advantage of these technologies.
- *Internet Access*—Few network issues have captured the public's attention like the explosive growth in the use of the Internet. State agencies need affordable access to Internet services. Basic needs include the ability to exchange e-mail, share data, and provide up-to-date information on demand. Agencies also need to establish electronic interfaces with their constituents, clients, and customers. Agency programs that may use the Internet include on-line application processes, electronic permits, and electronic payments and deposits. Of course, state agencies also need a secure method for verifying and guaranteeing the privacy, integrity, and non-refutability of electronic communications and other electronic transactions.
- *Workflow and Application Design*—State agencies have begun to take advantage of the new technologies supporting workflow and business intelligence applications. They have begun to shift some of their critical processing from legacy, mainframe-based systems to client/server networks. This decentralization of processing has enabled new workflow-based procedures that were not possible before. Examples include replacing manual, forms-based data entry systems with systems for capturing document images. There are obvious advantages in not having to process and move large amounts of paper-based documentation. Harvesting these advantages represents the first generation of benefits. The next generation of benefits will accrue from redesigning and reengineering work processes. Inherent in this shift is the need for efficient transmission of the data, including images and files. Remote offices will be recipients of data that once was only available at the main campus, thereby increasing network traffic on the infrastructure.

- *Staff, Support, and Other Expenses*—State agencies have started depending on a network that is available 24 hours a day, 7 days a week. Customers also expect electronic communications with governmental agencies without regard for day or time. The convenience and cost efficiencies gained by keeping the network available must be weighed against the additional costs of maintaining fault-tolerant, fail-safe systems. These costs have been extremely hard to justify in the current budget-sensitive environment surrounding state government. State agencies have to minimize financial impact wherever possible, such as by using frame relay instead of dedicated T1 lines. Even so, frame relay is double the cost of the old analog lines, and the associated routers/hubs cost more than the old control units. Maintenance of this equipment is costly, not to mention the travel required to maintain equipment in remote sites.

Finally, the state is at a disadvantage when hiring and retaining trained technicians. The expertise to maintain an advanced network requires advanced technical knowledge. The state does not pay salaries competitive with private industry, nor does it invest heavily in staff training. Often, an agency has only one technical expert to support critical systems, and lacks the funding and resources to train backup support. The state continues to lose staff, which usually results in the loss of irreplaceable institutional knowledge. Investing in the technical staff needed to keep the state's telecommunications network running must be as important as investing in new technologies.

Health and Human Services

The health and human services agencies, prior to 1994, each operated a separate data network to provide services to their customers. In order to raise service levels and lower costs, the agencies formed the Health and Human Services Consolidated Network (HHSCN). The HHSCN is a routed, wide area network (WAN) that was originally created in September 1994, to share network costs and services among the twelve agencies, whose need for extraordinarily high network performance levels was not being met by their individual networking solutions.

The HHSCN currently serves 739 locations around the State of Texas, from large urban areas to small rural offices. Of this total, 282 sites are offices in which staff from several different state agencies are co-located. By sharing WAN and LAN resources, facilities, and facility management, agencies at these sites are able to eliminate redundancy, reduce operating costs to taxpayers, and provide clients easier access to a broader spectrum of state agency services. Over 30,000 workstations are connected to the HHSCN and the network contains 206 inter-LATA and 696 intra-LATA data circuits, routed through 11 nodal sites around the state. Continued growth is expected

as several health and human services agencies add sites and others bring more of their sites into the network.

Reliability and quality are essential to the customers of the HHSCN. The health and human services agencies have exceptional network requirements in order to meet their business and client service delivery needs, many of which are legally mandated. One such requirement is network availability, 24 hours a day, 7 days a week. For example, the Texas Department of Protective and Regulatory Services operates a 24-hour child abuse hotline, which must remain operational at all times. The Texas Department of Mental Health and Mental Retardation must be able to access client records to admit a person to care, obtain medications, and access centralized or remote admission or health records. Parole officers receive calls at all times of the day and night, and need information from the Texas Youth Commission immediately. When police officers encounter an individual who is exhibiting irregular behavior, they require that the Texas Department of Mental Health and Mental Retardation be able to provide immediate information about the client for the officers' own safety or that of others.

The service levels established by the HHSCN ensure that all customers receive consistently reliable, high-quality service. The minimum, prime-time service levels for backbone, intranodal, and individual data circuits are 99.5%, 98.5%, and 95%, respectively. In fiscal year 1996, the HHSCN consistently surpassed its minimum service levels.

This high level of service can be maintained due to several factors, including:

- Agency representatives are on the HHSCN Board of Directors
- Interagency work groups provide technical oversight and direction
- Service level requirements are related to the rate model (i.e., a higher rate for higher demands of service), and include agreed-upon service levels in the interagency contracts.
- Outsourcing contracts require accountability on the part of the contractor.
- Reports on service levels achieved, circuit utilization, and customer satisfaction survey results are regularly prepared and communicated to customers.
- An Annual Report, Service Level Agreements, Operations, Policies, and Board Minutes are developed and published.

As previously stated, costs have also been a major reason for the creation of the HHSCN. In order to maintain costs, the following principles are followed within HHSCN and should be implemented in a statewide network.

- As agency budgets are set far ahead of the actual expenditure, a clear plan for dealing with unexpected rate increases must be developed.
- A plan is needed for how the rates will be established or reviewed, who will approve the rate model, how rates will be published, etc.
- Involvement of the customers in any decision making that would affect agency costs is essential.
- Independent financial and operational audits must be conducted.

Other important requirements of health and human services agencies include:

- As new policies are established by DIR, GSC, or the TPG, a migration plan and funding request should accompany their release.
- If agency assets are to be transferred into a cooperative venture, barriers and solutions to transferring software licenses, hardware warranties/maintenance, and bonded equipment should be investigated.
- Nonpayment by customers should be addressed so as not to impact rates for other customers.

A summarization of the services HHSCN provides to meet its customers' requirements are:

- Network availability, 24 hours a day, 7 days a week
- Internet connectivity and services
- Integrated electronic mail services
- Remote print services
- Dial-up support
- Network operations and management
- A centralized service desk
- Centralized and remote network monitoring using sophisticated network management tools
- More than 170 trained and experienced support staff in more than 60 offices providing statewide network support

For both voice and data, services have included:

- New technology evaluation and integration
- Capacity planning
- Data circuit administration
- Network management and design
- Project management
- Change management

Voice Requirements

The health and human services agencies have complex voice requirements throughout the state. These requirements include:

- *Integrated Voice Response (IVR)*—an existing IVR system processes over half a million calls per month, which are received from clients checking their benefits.
- *Shared Phone Service*—co-located sites' phone service has been provided to meet the requirements of all customers.
- *Call Identification*—large locations have systems that identify incoming calls, which is an essential component of the security strategy.
- *Voice Mail and ACD (Automated Call Distributor)*—extensive systems are installed statewide with complicated ACD activated at many of the sites.
- *Service Intervals*—customer requests for changes in service receive a high priority. Normal moves and changes are accomplished within three working days.

High quality and reliable service is an integral part of all voice offerings. Service levels of 99.5% prime and 98.5% non-prime are consistently exceeded.

Video Requirements

There are increasing demands for state agencies to conduct business more effectively and efficiently. The demands include better communication within and among agencies, coordination of services and programs, increased staff development and training for customer service, and better education and management of state contractors and contracts. As government jobs change and these demands increase, travel budgets are cut and agencies are faced with FTE caps. The question is how can agencies become more effective given the constraints of travel budgets and staff.

The use of telecommunications technology for improved and enhanced communication and education is being recommended as a way to meet the above demands. Videoconferencing in the form of two-way interactive teleconferencing, satellite broadcasts, and Internet communications is being recommended and even, in some instances, is a required way of conducting business. Lately distance learning has been written into federal grants and in the state appropriations bills to use videoconferencing to offset travel expenditures. While vendors estimate a potential 30% travel savings upon

implementation of a video network, there is a significant capital equipment expenditure and recurring line charges required to operate such a system.

Health and human services agencies have deployed extensive videoconferencing systems statewide for:

- Customer education with the goal of providing them with the skills necessary to become self sufficient and free of welfare.
- Staff training in the latest mandates and procedures to help them perform their functions efficiently and correctly.
- Staff participation in graduate courses, provided by the university community, which allows them to upgrade their professional credentials.

In addition to large systems, Desk Top Video is also deployed. These systems are used for one-to-one communications or in small groups that have a common project or interest. Videoconferencing is usually transmitted at one-quarter to one-half T1, while Desk Top Video transmits over ISDN or the Internet. Video initiatives continue to expand as travel budgets become more limited.

Since video is becoming more and more an issue for development, it should be an integral part of statewide planning. The issues facing health and human services agencies, as well as other state agencies, are:

- *Determining suitable applications for videoconferencing*—The list of applications that can benefit from videoconferencing is expanding. There are significant administrative, education, and telemedicine applications to justify the development of a statewide network for videoconferencing.
- *Securing funding for such a network*—Currently with each agency funding its own telecommunication initiative and limited joint use of sites, redundancy and waste of taxpayers dollars are possible. A consolidated and well-run videoconferencing network could make videoconferencing available to a wider audience.
- *Operating a videoconferencing network*—A central videoconferencing network for all agencies should be supported by the General Services Commission.

In summary, the stringent service requirements of availability, reliability, and cost containment required by the health and human services community must be evident in the GSC-operated network. Because the service requirements for the health and human services community are quite unique from education, criminal justice, and general government, creating classes of service that would meet specific user needs may provide the most economical approach to

network consolidation. The “one network serves all” approach may place undue cost constraints on network users with far less stringent requirements.

Local Government

Local government telecommunications requirements are similar to state agency needs. These requirements include the need for telecommunications transport for voice, video, and data applications and access to the Internet. Though not required to use TEX-AN services, local government entities can reap the benefit of the bulk purchasing power of the state for these services.

The relationship between the state and local governments in the use of TEX-AN services is symbiotic. Though the state network cannot serve private industry and most nonprofit entities, telecommunications and Internet services on TEX-AN are made available to city and county government and their political subdivisions. Local government benefits from the lower rates and services available on TEX-AN. This includes reduced rates for long distance services, telecommunications circuits, and rates for Internet access. These rates are available throughout the state and are especially needed in rural and remote areas. Local entities using TEX-AN services have these charges consolidated from a single entity, yet are provided the best available services from the leading telecommunications vendors. Cities and counties that can negotiate better rates in metropolitan areas are free to procure services by other means.

The state, in turn, is assisted by the added bandwidth requirements needed to serve the local areas. The state receives the discounted rates based on the bulk procurement of services. The added traffic for long distance voice and local telecommunications services aids the state in receiving additional discounts from vendors providing these services. Additionally, with the added requirements of local government in rural areas, state costs can be reduced for intra-LATA services in the area. The state, as an anchor tenant, can help serve rural communities by ensuring vendors provide enhanced and quality services in these disparate regions.

As the number of local government customers served by the TEX-AN network increases, the state must ensure that the needs of the local community are addressed by the infrastructure. This can be accomplished by developing ongoing dialogues with representatives from the counties and cities and collaborating with organizations such as the Texas Association of Counties and the Texas Municipal League, among others. This symbiotic relationship ensures better services for the citizens served by state and local government.

Electronic Commerce

Legislation introduced in 1997 exemplifies the growing awareness of the need to facilitate the implementation of electronic commerce within state government. Legislation passed by the 75th Texas Legislature includes:

- Senate Bill 370, allowing the Texas Department of Transportation to implement an electronic bidding system for highway construction and maintenance.¹⁷
- House Bill 984, allowing certain agencies to accept written electronic communications that have been authenticated by means of a digital signature and requiring that the Department of Information Resources implement rules for the use of digital signatures.¹⁸
- Senate Bill 820, requiring the General Services Commission (GSC) to establish and operate an electronic procurement marketplace, including an electronic commerce network.¹⁹

These bills, along with independent agency initiatives, point to the growing use of the state networks for completing procurement and financial transactions electronically. In order to support these transactions, the statewide infrastructure will need to provide the mechanism for the intergovernmental exchange of information and the need for interfaces with private industry networks. The following are needed on agency networks in order to facilitate the implementation of electronic commerce:

- Network security, including encryption, in order to prevent fraud.
- Statewide standards for system interfaces in order for agencies to exchange information with the private sector.
- Open connectivity in order to support existing agency and university systems.
- Access to private networks and the exchange of information with private industry in order to complete transactions.
- Network bandwidth to support increased traffic and ensure adequate response times.

GSC has established the Electronic Commerce Task Force to study the feasibility and costs of implementing an electronic marketplace for electronic commerce. A report on the study will be submitted to the Legislature in 1998.

C. Status of Infrastructure

The existing statewide consolidated telecommunications network (TEX-AN III) was installed over a six-month period between September 1993 and February 1994. TEX-AN III is a multi-node, hybrid network utilizing digital facilities on the backbone and within each Local Access and Transport Area (LATA) where services are available and cost-effective. All inter-LATA network circuits are routed over fiber provided by Interexchange Carriers. Integrating voice, data, and video requirements on common facilities resulted in improved bandwidth utilization. Multiple nodes are configured to accommodate network traffic requirements and to provide alternate routing and disaster recovery capabilities. Users are able to access the network for voice services through either virtual or dedicated arrangements, depending on the cost to serve each end user and the anticipated amount of traffic. Dedicated facilities are available for data and video requirements at operating speeds from sub-DS0 through DS3.

The telecommunications architecture for TEX-AN was developed to provide comprehensive support for all state agencies and other political subdivisions electing to subscribe to these services. The architecture provides a solid statewide infrastructure and is adaptable to changing requirements while being able to incorporate advantages of emerging telecommunications technologies. Network presence is provided in all seventeen LATAs in the state. Primary switching hubs are strategically located in eight LATAs, while all LATAs are served by Newbridge DS3 digital multiplexers (commonly referred to as Transmission Resources Managers or TRMs).

Management of network resources is provided through the central network management system of the Newbridge TRMs. The network management system provides network-wide reporting and proactive maintenance. TRMs use industry-standard physical interfaces to customer devices, as defined by national and international networking standards. The design of TEX-AN provides alternate connectivity and routing functions to each of the TRMs for data redundancy. Voice traffic can be pre-empted so that only critical data applications will be carried on the alternate routes in the event of a major circuit outage. The TRMs give network management personnel the capability of performing cross-connect functions, automatic alternate routing, bandwidth allocations, priority traffic handling, and network management.

In February 1997, the General Services Commission and the Department of Information Resources began the consolidation of the DIR service bureau into the Telecommunications Services Division of GSC. The consolidation was completed in April 1997 and resulted in the integration of CAPnet and

VidNet services into the statewide TEX-AN network, thus increasing efficiencies and reducing operating costs. The collective talent of both organizations was merged in a manner allowing the focus to be placed on providing quality and cost-effective services to the user community. This new consolidated and more focused effort allowed for major expansion into new service areas.

The merging of the TEX-AN statewide routed data network with CAPnet consolidated state government's access to Internet service providers (ISP). Additionally, the tremendous growth of Internet requirements for public school districts, public libraries, and not-for-profit hospitals resulting from the availability of House Bill 2128 rates, has led to a need for GSC to contract with an ISP for DS3 access to the Internet. Also, GSC has recently begun working with the University of Texas at Austin and Texas A&M University on providing high-speed, shared access to the Internet and access between GSC's routed data network and the university networks. In order for each network to serve as a backup to the other, an additional DS3 connection to an Internet service provider will be required in the near future.

TEX-AN has provided video services over the network within the past year due to specific needs expressed by the Office of the Attorney General, the Department of Criminal Justice (TDCJ) and the U.S. District Courts. Hearings with prisoners require continuous-presence video monitoring and a four-way split screen to be preserved as a permanent record. Since implementing the TDCJ video network, the GSC/DIR merger of the service bureau has added a forty-site, dedicated video network (VidNet) to the suite of TEX-AN services. GSC has also contracted with Southwestern Bell for multipoint video services (MVS) to enable the interconnecting of video networks throughout the state. VidNet has been connected to the MVS bridge and GSC is working with other state agencies and universities with statewide video networks to provide similar connectivity, thus increasing the value of the state's multitude of video resources.

Although TEX-AN III has successfully met most telecommunications needs of its customers in a cost-effective manner, the network has reached the limits of the economies of scale available through the T1 and DS3 technologies. Bandwidth requirements continue to grow, especially for data and video applications. As more bandwidth is needed, GSC is able to add T1 and DS3 facilities, but cannot upgrade to other higher capacity services, such as SONET, under the existing network design. Universities have expressed a need for greater bandwidth to support the Very high speed Broadband Network Services (vBNS), Internet II, and the Next Generation Internet. This will require implementation of a fiber-based SONET infrastructure.

Contracts for TEX-AN III equipment and services expire in August 1998. Although these contracts have renewal options available, the growth in network traffic and requirements indicate an immediate need to begin the design and implementation of TEX-AN 2000.

5. Analysis

Texas Government Strategic Plan for Telecommunications Services

A. Guiding Policies

This Telecommunications Plan strives to support related statewide initiatives and goals. Conversely, the goals of the Telecommunications Plan are guided and limited by legislation, policy, and administrative rules. The following affect, to some extent, the direction of this document:

- *1997 State Strategic Plan for Information Resources Management (State Strategic Plan)*—The State Strategic Plan identifies the approach for providing government information to the public, including the technological shortcomings that need to be addressed, and sets the state's direction in remedying the shortcomings.²⁰ The document identifies the shortcomings of the existing state telecommunications infrastructure and the need for coordination in developing a statewide system. Furthermore, the first goal of the State Strategic Plan discusses the need to develop, implement, and maintain a statewide information resources infrastructure for the state. Other objectives proposed by the State Strategic Plan include adoption of standards for open systems, interoperability in design, and addressing user needs in planning developments; all goals supported in the Telecommunications Plan.
- *TEX-AN Legislation*—The TEX-AN network operated by GSC can only provide services to government-funded state agencies, universities, colleges, and local government for intercity telecommunication services. GSC does provide services to nonprofit organizations through one of the supported entities, but is limited in this capacity. The 1994 *Texas Telecommunications Strategic Plan* addressed the need to allow the state to partner with private industry in order to deploy advanced services and to allow private traffic on TEX-AN to permit delivery of integrated information in the public interest.²¹ No action proceeded on these recommendations.
- *Legislative Intent*—The TPG legislation in Senate Bill 365 clearly directs the state to develop and migrate towards a consolidated telecommunications infrastructure.²² Individual agency requirements and the advancement of new and different technologies may be cause to revise this mandate and refocus the implementation strategies.

- *DIR Administrative Rules*—DIR has the authority to adopt rules that will guide agencies towards meeting the goals and objectives set in the State Strategic Plan. DIR has adopted standards in a number of areas, including networking (TCP/IP²³) and videoconferencing (H.320²⁴), and requires agencies to migrate to the TCP/IP standard by 2001. The Telecommunications Plan will endeavor to implement an infrastructure to support this standard and others that may be proposed in the future.

B. Issues with the Existing Infrastructure

The TEX-AN network is primarily a series of contracts to provide telecommunications services. These services include, but are not limited to:

- Digital and analog data circuits up to T3 bandwidth to most locations in Texas (rural and remote area service availability varies)
- Long distance voice services: intra- and interstate and international
- Toll-free and 900 services
- Network management and support

Since the initial implementation of TEX-AN III, GSC has extended the services provided to agencies to include a statewide IP/router-based network for intrastate and Internet access; and continued support for the VidNet video network transferred from DIR; and operates a fiber SONET ring in Austin to support high-speed and bypass options for agencies within the city. GSC also provides technical assistance to agencies in order to help them implement business requirements on TEX-AN. Billing and accounting services are centrally managed within the Telecommunications Services Division of GSC.

Both management/support issues and infrastructure-related problems have been identified with the TEX-AN network.

Management and Support Issues

The management issues include customer concerns with billing and network costs. The power of a consolidated network is reduced cost to all the participating agencies. The current system utilizes the concept of cost averaging for particular services, in which some customers will be charged less than actual costs and some customers will be charged more than actual costs. In some cases, the result of this billing structure is that a few customers are being charged more for a service than they can receive directly from a carrier. This prompts some agencies to request waivers from TEX-AN, so that they may order directly from carriers or consider alternative technologies, such as satellite communications.

A requirement for the new system may be to provide each service on an “at-cost” basis to customers. Any service thus provided by TEX-AN should be less expensive than service an individual customer could receive directly from a carrier.

A counter viewpoint to this is that TEX-AN contracts are based on statewide services, not particular to a single area, and in the best interest of the state. Though individual agencies may receive lower costs in some areas, the state as a whole may not end up getting lower savings. The purpose of the TEX-AN network and the reason agencies are required to use TEX-AN is to reduce overall state costs and provide affordable services to all agencies.

However, TEX-AN services should be provided with these considerations:

- Feasibility of passing actual circuit costs billed by the carriers to the customers and then applying overhead.
- Cost structures for services should be designed with customers and published with full disclosure.
- Overcharges on the existing billing system must be identified within 30 days by an agency or the charges will not be refunded. This occurs even though the billing is sometimes up to two months late. Currently, all overcharges must be paid in full and the agencies credited, if GSC concurs, in the future. This causes agencies problems in keeping up with the accuracy of past-due credits.
- Refunds by carriers to TEX-AN due to circuit outages and rate reductions should automatically be passed through to TEX-AN customers. Currently, these are provided to GSC, but are not passed through in a timely manner.
- The final cost recovery of a capital investment (paid via rates charged to customers) should be followed by rate reductions to customers after the investment is paid in full.
- Raising capital for improvements should be identified by a capital improvement charge listed with overhead charges of services.

The support issues are related to performance of the TEX-AN network and support staff working with the customers. Customer and service provider expectations should be clearly understood

through the use of a service level commitment with the service provider, in this case the GSC’s Telecommunications Services Division. TEX-AN agency users are required to use the TEX-AN network and have few options, as a

private corporation does, to look for remedies through bidding out services or specifying service levels for contracted services.

Areas to be considered in order to improve or satisfy customer requirements include:

- Develop service levels and service level agreements in direct consultation with customers. In particular, service levels should be developed in conjunction with customers to meet specific customer requirements.
- Hold regular meetings with individual customers to review service level compliance.
- Disseminate information to customers, in a timely manner, informing them of planned network improvements and changes. Provide customers with progress updates.
- Foster customers' vested interests in the development, management, and operational planning of the infrastructure. Meeting the varied and constantly evolving needs of customers is paramount.
- Establish periodic, scheduled planning sessions to solicit input from customers. This could include an ad hoc committee made up of GSC and major customers to develop long-range plans.
- Establish a mechanism for ensuring customer service and responsiveness to the TEX-AN customers.
- Review the need to increase GSC's administrative charge in order to increase support, resources, and network management to meet the customer needs.

Infrastructure Issues

TEX-AN has implemented a statewide IP/router network to support customer needs for connectivity. At this time, use of the data network is voluntary. In order to meet the mandate to consolidate all networks onto a single network, all agencies would be required to use a single, router-based infrastructure. Various issues related to the use of a single, router-based infrastructure need to be addressed before this becomes a reality.

The current router infrastructure connects agency and local government sites through hub routers (either the Cisco hubs or the TEX-AN frame relay hubs). The following areas are of concern to agencies:

- Agencies using the router infrastructure share the backbone network with school districts, libraries, and other non-state governmental entities. There are concerns that unrestricted access to the Internet may affect agency access to governmental systems. A means to ensure the prioritization of traffic may need to be developed.
- The infrastructure should provide statewide connectivity at reasonable rates. A router infrastructure requires regional hubs in order to reduce local access costs. It is currently not feasible for the TEX-AN network to implement hubs to all state regions. Currently, there is a hub presence in each LATA, but it is costly to extend the hub infrastructure to a broader level (hubs in each county, etc.).
- Other technologies, such as satellite transmission, may provide alternatives to providing routed services to all locations. This may present a problem in consolidating all services into a single backbone.
- Security and privacy of information remain an issue in some governmental agencies. The network must be able to ensure a secure and private transmission path. This can be accomplished by creating shadow networks or community-of-interest networks.
- TEX-AN must show the ability to support all customers, as new local entities continue to be added to the infrastructure. Local government agencies, such as libraries, schools, etc., have a choice in connecting to TEX-AN, but agencies do not. If agencies are required to migrate to a consolidated environment, the TEX-AN support must show the ability to maintain customer satisfaction as the installed base is increased.

C. Functional Requirements of the State Infrastructure

Overview of Agency Requirements

Agency telecommunications requirements can be grouped into three broad categories:

- *Telecommunications Transmission*—The actual transmission backbone required to support telecommunications activities. The telecommunications infrastructure needs to supply the basic circuits (T1, T3, 56 Kbps, analog, etc.) needed to support the agency networks and requirements. A statewide SONET infrastructure can address most of these requirements.

- *Connectivity*—The backbone infrastructure must support an access means for connectivity. Agency telecommunications services include voice, video, data, and wireless technologies. The network must support connectivity to the backbone through a distributed hub arrangement. Until a multi-application technology such as ATM or B-ISDN is implemented on the backbone, connectivity for each of the services may need to be accomplished separately. Access should be statewide at cost-efficient rates.
- *Support*—The statewide infrastructure must be adequately supported and agency service levels met. A central network center should support all user support functions and maintain the quality of the services provided.

The agency requirements identified in this section can be addressed within the following categories.

Agency Functional Requirements

The functional requirements of the state agencies and universities vary to a great extent. The extended support requested of the infrastructure now also includes local political entities, such as schools, city and county governments, libraries, and police and sheriff departments, to name a few. Among the common requirements, the following are most prevalent:

- *Security*—Security requirements extend to preventing unauthorized access to the network, restricting access to information and systems, and securing transmission of data and information. It is generally accepted that agencies are responsible for securing the actual platforms, systems, and data residing at agency sites. Depending on the security level desired, the network should provide capabilities for data prioritization, encryption, and restricted data routing, such as filtering of IP addresses or applications.
- *Statewide Connectivity*—Network connectivity must be available, at cost-efficient rates, at all state-served locations. Accessibility should also include enhanced telecommunications services such as digital access, access to routable networks, high bandwidth requirements—even in remote areas, and fast delivery across the backbone infrastructure.
- *Citizen Accessibility*—Network connectivity should realize the access requirements of the state citizens and the state agencies' needs to provide information to the public. Additionally, access to agency files is being required for such functions as checking employee backgrounds (teachers, day care workers, bus drivers, etc.), handgun procurements, concealed weapon checks, and other such verification requirements. Though the

statewide infrastructure does not provide direct connections to citizens or private corporations, agency functions include making information available and the need to extend the accessibility of this information.

- *Internet Access*—There is a growing need to provide state services and address state agency requirements through the Internet. The state infrastructure will need to support connectivity to the Internet for citizen access, electronic commerce, information exchange, statewide e-mail, and research access, among other uses. Issues with IP addressing, firewalls for security, network congestion, and data prioritization will need to be addressed in a consolidated environment.
- *Interoperability and Standards*—The statewide infrastructure needs to be based on standards supporting interoperability of vendor products and support multiple networking protocols. GSC currently operates CAPnet, the capitol area FDDI ring running the TCP/IP protocol, which connects most of the state agencies and provides interagency communications and Internet access. A statewide data infrastructure should be based on similar open technologies. The current statewide data network is being transitioned to provide similar services.

A key issue is the ability of such a router infrastructure to support different vendor equipment. An open infrastructure should be able to support multi-vendor equipment, similar to the Internet.

- *Support for Regional Networks*—The growing support for local governmental entities and schools requires the state infrastructure to support regional connectivity. Regional networks operated by consortia enable the local control of networks and reduce the network management load required from the state network center. Statewide and Internet access to the regional networks should be provided by the statewide infrastructure. Development of consortia and regionalization of networks should be encouraged as a means to better address user support needs.
- *Community-of-Interest Groups*—A consideration of the statewide network is to support different groups of users with different criteria. There is a need to identify and prioritize agency traffic from non-business/governmental traffic. As an example, traffic from school districts and libraries may be routed on separate backbone links, isolating the traffic from agency transactions. Additionally, law enforcement/criminal justice and health and human service agencies are currently building community-of-interest networks. These agencies' network needs and the requirement to consolidate all state agency networks should be thoroughly evaluated

before drastic changes are recommended to the existing or proposed configurations.

- *Response Time Criteria*—The network infrastructure must meet the individual agencies' response time needs. This includes providing sufficient bandwidth on the infrastructure and allowing for the creation of shadow networks or community-of-interest networks. The development of service level commitments to agencies to ensure response time criteria is a consideration.
- *Service Commitment*—Agencies need to be assured of certain levels of network reliability and uptime. This includes all circuits for voice, video, and data, but is more critical when considering a consolidated data network. As agencies migrate toward a single data infrastructure, individual agency requirements need to be evaluated and service levels established to meet each agency's needs. An efficient and knowledgeable central management and information center is required to provide this support.
- *Central Support*—The need for a well-trained central management team is a key to implementing a statewide infrastructure supporting all agencies and local connections.
- *Advanced Technologies*—The state infrastructure will need to support advanced cell switching technologies, such as ATM and B-ISDN, in the future. Planned infrastructure implementations need to consider migration support issues to implement such technologies. Existing packet switching technologies (frame relay, TCP/IP routers, etc.), though currently meeting most of the state needs, will be the legacy systems of the future. Application requirements by universities and the early signs of congestion on the Internet point towards the need to implement gigabit bandwidth networks in the 21st century.
- *Local Services*—The current telecommunications deregulation environment and the dawn of competition in the local markets will lead to new opportunities for cost reductions in the local exchange market. Rates in Texas are among the highest in the nation and the state needs to take advantage of opportunities in this area in order to reduce overall agency telecommunications costs.

These service requirements and functional needs should be a major consideration in the implementation of TEX-AN 2000. Current voice, video, and data transmission services need to be augmented with the functions described above. Services not available on the backbone should be added as

separate services, when feasible. The state should also consider the need to provide advanced services, through legislative or other funding sources, at reduced rates in order to encourage the development of advanced telecommunications applications for state agencies. This could include remote video facilities or video backbone, gigabit demonstration networks, and implementation of wireless technologies.

Technology

The state continues to review the available technologies for implementing statewide telecommunications services. In proposing technologies for the state network infrastructure, state applications supporting voice, video, and data transmission must be considered. Legacy systems and new implementations must also be included in the technology equation.

Satellite vs. Terrestrial

The state continues to investigate the need for satellite transmission on the statewide network. Opportunities exist for data transmission requirements, statewide video broadcasts, and support for remote locations. Satellite transmission also provides an opportunity for providing local exchange services, bypassing the local carriers in selected locations, or as a means to balance the costs associated with tariffed rates.

Though satellite transmission is a viable alternative for selected agencies or applications, issues remain that inhibit the use of satellite technology for backbone applications. The propagation delay for satellite transmission (270 milliseconds for transmission and a total average of about 320 milliseconds delay when software and switching is included) currently prohibits the use of satellite transmission for day-to-day voice business transactions. In general, satellite transmission is not recommended for highly interactive applications including voice, interactive video, and response-sensitive data applications.

This limits the use of satellite technology on the backbone infrastructure. However, satellite technology is a consideration in some of the agency plans and the state will consider its use in future applications or as an additional contracted service for TEX-AN.

Next Generation Satellites

The next generation of broadband earth-orbiting satellites is planned for low earth orbit (LEO). LEO is defined as less than 2,000 kilometers above the earth. Because LEO satellites are closer to earth, uplink signal requirements to these satellites are 1/2000th of the power requirements of uplinks to satellites

in geosynchronous earth orbit. In addition, because of the close proximity of LEO satellites, the total average delay of 320 milliseconds is experienced in GEO satellite systems is non-existent in LEO satellite systems, making telephony and videoconferencing applications possible.

Over the next six or seven years, possibly as many as a dozen data-oriented LEO satellite systems are planned to go operational. These next-generation-satellite systems are projected to have initial data transfer rates of 64 Kbps to 155 Mbps. Pricing for services has yet to be determined, but is projected to be less than the price of services offered by GEO satellites.

Providing the citizenry of Texas with equal access to a statewide network will continue to be a major challenge. The size and complexity of this challenge makes it clear that any final solution will include a combination of terrestrial, cable, satellite, and wireless technologies. Within the next decade it may be possible for the state to utilize wireless technology to connect rural/remote areas of Texas and to address cost and bandwidth issues associated with the last mile.

Terrestrial Technologies

In implementing a statewide infrastructure for the future, the state needs to consider current technologies used by the carriers. Of these, synchronous optical network (SONET) and asynchronous transfer mode (ATM) are the most viable. SONET is the standard for multi-megabit transmission hierarchies in North America (synchronous digital hierarchy, SDH, is the international standard and is based on SONET) and operates on fiber-optic cables. ATM is a cell switching technology for transmission and is the basis for the development of Broadband ISDN (B-ISDN). SONET operates at the physical layer of the transmission standards. ATM requires this physical layer in order to operate at the multi-megabit ranges. Thus, SONET operates at a lower level than ATM and the two are not competing technologies, but rather, complimentary enabling technologies.

Additionally, in considering the use of SONET or ATM for the infrastructure, certain aspects for implementing ATM need to be evaluated. ATM standards for the wide area network have not been fully developed. Furthermore, the switch to ATM technology is a major revolutionary shift from circuit switching to cell switching in the public networks. Some of the problems in ATM application implementation may not be identified until further tests have been performed. Issues with the transmission of isochronous traffic (voice and video) have not been completed and the interface with existing data protocols, such as TCP/IP, are still being resolved.

The state needs to consider a technology that is currently widely used and not still being tested. Additionally, the technology will need to support and enable a variety of transmission applications. SONET seems the most viable transmission technology at this time and the state will continue to research its use within the state infrastructure. The use of ATM technology on the infrastructure will be dependent on agency requirements.

Network Management

In implementing the statewide infrastructure, the state needs to ensure that proper management systems are in place to monitor and control the network. The need for a comprehensive, central network management system becomes more pertinent when considered with the current staffing environment. Technical staffing limitations, including trained staff capable of managing the technology and the state's ability to retain these staff, are a major consideration in implementing and supporting a state-of-the-art telecommunications system. The state must have an operational support system and organizational structure to manage an enhanced network. This area involves day-to-day issues that are better addressed in an operational context and will be a continuing area of support and discussion by GSC.

6. Goals and Objectives

Texas Government Strategic Plan for Telecommunications Services

The Telecommunications Planning Group (TPG) was given a mission by the Legislature to establish a statewide consolidated telecommunications network. The TPG and Advisory Agencies have established a vision that will be realized with the infrastructure. The Telecommunications Plan intends to fulfill the mission statement and vision with a set of goals. The state infrastructure will enable agencies to achieve the following goals:

- Provide citizen access to government information and services
- Provide the platform for access to educational resources
- Provide essential network services to government agencies
- Consolidate agencies' statewide network requirements
- Centralize access to network services and information
- Facilitate the exchange of government information
- Provide open interfaces for connectivity

These goals provide the direction for achieving the vision proposed in Section 3. This section further explains the goals and their objectives.

A. Provide Citizen Access to Government Information and Services

One of the assumptions of the form of government that we practice, cherish, and expound is that information from the governing process is freely available. Our governing entities expect good citizens to be reasonably well informed about the actions of the governing bodies. Most state agencies readily agree with the public policy of providing affordable or free access to public information over the Internet.

Government information, in most cases, exists in electronic form; however, the inference that there is no additional cost to provide electronic access is incorrect. The infrastructure issues need to be addressed in implementing a broad policy supporting public access to government information over the Internet. The state infrastructure needs to support the technological improvements necessary to make the delivery of large amounts of secured information a common occurrence. In order to provide public access to information, the following objectives must be addressed:

- The state telecommunications infrastructure will support the philosophy of the 1997 State Strategic Plan for Information Resources Management, supporting citizen access and the free exchange of government information.
- The state network will be an open infrastructure for agencies, accessible to agencies throughout the state.
- The infrastructure will be centrally and cost-effectively supported to reduce agency and citizen access costs.

B. Provide the Platform for Access to Educational Resources

The state infrastructure needs to support the educational institutions' requirements, from K–12 education to the university level, including the supporting administrative agencies. The requirements at the different levels vary, but the basic need for statewide access is present. K–12 education requires Internet access as well as integrated voice, video, and data to each school location (currently 6,800 sites), while universities—the leaders in use of the Internet—are more concerned with bandwidth availability between institutions, currently approaching the gigabit range, and the need to support new technology and applications in telemedicine, research, and academics.

The state network needs to meet these requests by supporting the following functions:

- Implement a high-speed, network-based SONET technology to meet bandwidth demands of the several thousand sites and response speeds required at the university level.
- Enable statewide access to the infrastructure, regardless of the remoteness of the location.
- Provide central support for the schools by supplying technical resources, support, and information.
- Provide an environment to consolidate educational efforts in order to take advantage of financial opportunities.

C. Provide Essential Network Services to Government Agencies

The purpose of the statewide infrastructure is to provide agencies with a network that meets each agency's individual requirements and will assist agencies in meeting their legislative mandates and internal strategic business and information resources plans. The statewide network will support this goal by meeting the following objectives.

- Provide services to all locations served by state agencies.
- Address the statewide infrastructure requirements as outlined in the 1997 State Strategic Plan for Information Resources Management.
- Support the bandwidth requirements of the agencies.
- Enable technologies that will provide for the efficient and cost-effective transport of information to state agencies.
- Regularly review the needs of the agencies and ensure the infrastructure addresses these needs.
- Establish an information center to support the individual agency staff coordinating internal requirements.

In order to accomplish these objectives, the TPG must continuously receive input from the agencies and work with other monitoring and oversight organizations that affect the services provided by the state agencies. Plans must include review of the statewide infrastructure on a regular basis.

D. Consolidate Agencies' Statewide Network Requirements

The statewide infrastructure should be the focus point for the state's telecommunications requirements. Services required by agencies will be available on the network or explanations will be provided for excluding such services. Agencies requiring services not contemplated for the statewide infrastructure will be granted waivers to procure services through other means. The consolidated statewide network goal will be accomplished by the following objectives:

- The infrastructure will support the voice, data, and video requirements of state agencies.
- The backbone infrastructure will include all transport requirements for these services.
- Services not available directly on the backbone infrastructure will be made available through other mechanisms or agencies will be granted waivers from use of the infrastructure.
- Services for the statewide consolidated backbone will be purchased through bulk arrangements that will reduce the overall state costs.
- The infrastructure will support regional plans for implementing localized networks, allowing for local control and management of networks.
- The infrastructure will provide statewide connectivity points for agencies to access for their data network requirements.
- The agency connections to the statewide infrastructure will be supported by Quality of Service standards customized for each agency's needs.

The Telecommunications Plan's objective is for agencies to voluntarily comply with connecting to the consolidated network. This will be accomplished by

providing the needed services, by establishing support and service level guidelines, and by providing the services at a cost-efficient rate.

E. Centralize Access to Network Services and Information

Part of the attraction of a consolidated statewide infrastructure is the central support provided by the managing organization. The central support provides all functions required to assist customers and provide quality services. These services include:

- a single location for all questions and information requests;
- a central point for billing issues, rate information, and other support functions;
- an operations center for support of trouble calls and problems, including a tracking system to provide updates and status;
- a central network management system to integrate network configuration, inventory, trouble tracking, problem assignments, network status, and reports as needed, to supply support staff with the tools necessary to support the infrastructure; and
- a solutions and planning center to assist agencies in the implementation and optimization of their telecommunications needs.

The implementation of the central support functions are imperative for services provided to client agencies and are part of the concept of voluntary compliance by the agencies in the use of the statewide infrastructure.

F. Facilitate the Exchange of Government Information

Telecommunications is playing a bigger role in the exchange of information among Texas agencies and universities. Services such as TEX-AN (Texas Agency Network), CAPnet (Capitol Area Network), Internet, and the World Wide Web are providing services that affect state government business on a daily basis. Internal agency and university networks, as well as external networks, are changing how state government entities function.

The state infrastructure needs to facilitate and encourage the exchange of information by achieving the following objectives:

- As described in the 1995 State Strategic Plan for Information Resources Management,²⁵ the state needs to address the current information scenario of each agency being an “isolated island of information” by providing an electronic mesh effectively linking and facilitating the exchange of information among agencies.

- The state infrastructure will incorporate open standards, such as the use of TCP/IP adopted by DIR, in order to support the exchange of information. Additional initiatives that may be incorporated include the use of X.500 directories to identify and locate information.²⁶
- Agency initiatives, such as the Online Public Access Catalog and the Texas Records and Information Locator implemented by the Texas State Library and Archive Commission, should be readily supported on the infrastructure and agencies made aware of their existence.
- Support the state philosophy of gathering information once and using it many times by encouraging the exchange of information and identifying duplicative processes throughout the state. This can be accomplished through a statewide network supporting query and information identification that links the agencies' databases.

The Internet and the World Wide Web have changed the environment for the sharing of public information by providing an electronic option for distributing, searching, and accessing data. The telecommunications and computer technology available in the marketplace today permits state government entities to share their public information. With the proper security, agencies can also share confidential or private information for which the individual has a need to know.

G. Provide Open Interfaces for Connectivity

Connectivity to the network infrastructure will be based on open interfaces and standards as required to ensure interoperability. Agencies' connectivity will not be vendor-dependent and the infrastructure will not dictate the equipment procurement process. Open interfaces and standards required for connectivity will be based on the following assumptions:

- The statewide infrastructure will support standards that will promulgate and enhance the goals of the State Strategic Plan for Information Resources Management and ensure interoperability, security, and privacy in the infrastructure as required in the State Strategic Plan.
- Rules and standards adopted by DIR, including implementation of TCP/IP for all agencies, will be implemented on the infrastructure.
- The network will be vendor-neutral and acquired through proper procurement channels, ensuring interoperability with compatible equipment.

- Year 2000 issues will be addressed. See the Year 2000 Project Office web site (<http://www.state.tx.us/year2000/telecom.htm>) for more information.

The statewide network will be vendor-neutral, in regards to agency connectivity, and will expand, not limit, the choice of products and services available to state agencies.

7. Time Line for Success

Texas Government Strategic Plan for Telecommunications Services

A. Long-Term Vision for Implementation

The 1997 State Strategic Plan for Information Resources Management sets a ten-year vision for the state reaching its goals in information resources.²⁷ The Telecommunications Plan sets a shorter time frame of five to seven years in order to help implement the State Strategic Plan goals. This is accomplished by setting the long-term vision and goals and implementing short-term objectives to set the momentum towards these objectives.

The long-term time frame for implementation includes accomplishing the following objectives in five to seven years:

- The state must implement a statewide, fiber-based SONET infrastructure to support the telecommunications requirements of state agencies, universities, and local entities using the state network. The state infrastructure must also be flexible in adopting technologies as they develop in the next several years. Services not compatible with the infrastructure will be supported through contracts on the TEX-AN network, as requested by users.
- The state will develop a hub infrastructure to support packet-switched technology; initially router/IP-based hubs, with a migration plan to cell-switched technology (ATM, B-ISDN) to support the delivery of voice, video, images, and data to the sites on a single circuit.
- The cell-switched infrastructure, initially the router/packet infrastructure, is the basis for consolidation of all agency networks. Agencies will continue to be required to purchase intercity telecommunications services from the TEX-AN network. GSC will operate and manage the network and work with agencies for voluntary compliance on using the cell-switched/router-based infrastructure. The goal of voluntary compliance is that agencies will determine that the services provided on TEX-AN cannot be better provided by individual agency networks.
- The TEX-AN infrastructure will be supported by a centralized information and operations center that will preserve the quality of service to be provided on the network. Among the priorities of the central information

center are the development and support of service levels to the users, a centralized network management and accounting system, and technical support and solution group providing guidance to agencies on the best use of resources.

- The infrastructure will support the requirement to network by communities of interest. This is accomplished by developing shadow networks on the infrastructure, as needed, to support sensitive information and security requirements, to facilitate the development of regional networks and consortia by providing statewide and national access and technical support, and to work with existing statewide networks in preserving their integrity in the proposed environment.
- Develop a funding mechanism for the initial implementation of the infrastructure and a means for the network to self-sustain itself through recovery of funds from the users.

The first step in reaching these objectives is reviewing the existing infrastructure and determining the next sequence in implementing a SONET-based network.

B. TEX-AN 2000

TEX-AN III contracts expired in August 1998, with options for renewal on a month-to-month basis or annually. These contracts are for switching services (Southwestern Bell), Newbridge DS3 multiplexers (Southwestern Bell and GTE), long distance services (AT&T, American Telco, LDDS Worldcom, and NTS), and bandwidth (AT&T, MCI, LDDS Worldcom, and NTS). The tremendous growth in TEX-AN services over the past four years and the need to support new services and high-speed applications indicate an immediate need to begin the design and implementation of TEX-AN 2000. Although a complete replacement of TEX-AN cannot be achieved by the end of August 1998, the design of the current network facilitates a phased implementation of the new network. The new network, with higher capacity, must be built to keep pace with available technology, return to a model allowing economy of scale, and provide a cost-effective solution that allows for future growth.

Several of the major state universities have identified major initiatives that must be met by an enhanced state telecommunications infrastructure. Without a state network backbone capable of meeting these initiatives, various groups in Texas will need to develop separate networks resulting in sub-optimal use of state resources. The proposed initiatives are:

- Expand higher education's existing distance education applications to deal with non-traditional students at a time and place convenient for them.
- Continue the ongoing university provision of content for K-12 to enhance learning.
- Enhance and expand telemedicine initiatives currently underway in Texas.
- Increase access to national, high-performance computing resources and expand bandwidth needed for research.
- Enhance capability for Texas educational networks to access national networking initiatives to increase speed.
- Continue to support the use of multimedia applications in distance education.
- Continue to develop and support electronic library services.
- Leverage the educational network for access to the Internet.

In addition to the above initiatives, the new TEX-AN network must meet the needs of all state government and both K-12 and higher education for voice, data, and video requirements and be capable of achieving a single centralized telecommunications network for state government. The state infrastructure must enable the agencies to achieve the goals contained in Section 6 of this plan.

The implementation of TEX-AN 2000 will begin in fiscal year 1999. Existing contracts will be extended as needed to ensure a smooth transition. It is estimated that the transition to TEX-AN 2000 will take as much as two years. As stated previously, the design of the existing network facilitates the transition to a new infrastructure and should not require the massive change-out required of previous network conversions. The initial focus should be on replacing the existing backbone with a high-speed SONET infrastructure. Customer access facilities can then be changed or upgraded as needed to meet new applications or growth in existing applications.

C. Reaching the Goals

The goals depicted in Section 6 are addressed by the proposed network. A SONET-based infrastructure with a packet-switched/regional hub backbone network arrangement will address the goals as follows:

- The statewide SONET infrastructure will provide agencies with the ability to extend and support state services to all regions of the state on an efficient high-speed system. The infrastructure is the basis for providing government services and providing citizen access to government information.

- The statewide SONET infrastructure will be designed in conjunction with the state universities as central players in providing support for the network and as sites for regional hub locations. Access to the high-speed backbone by universities and an increase in the state infrastructure bandwidth for Internet access for K–12 education is a key in meeting the goal of providing a platform for access by educational institutions.
- The proposed high-speed SONET infrastructure and the implementation of a tele-management system to support the system and the TEX-AN users will provide agencies with the tools necessary to provide essential government services and addresses the need to support the services through a central information center. GSC will continue to address customer needs through the central information center and feedback from the customer base.
- The SONET infrastructure will support all of the state bandwidth requirements for voice, video, and data. The continued development of the regional hub router data network for agency data connectivity, based on voluntary usage, and the possibility of future deployment of a packet-switched network, will lead to the continued establishment of a consolidated statewide network for data communications. Issues with community of interest networking will be addressed through network regionalization, priority service levels on the backbone hub routers, and the implementation of shadow networks, if necessary, to support secure and confidential transmissions. If required, special exemptions from the use of the state network will be granted to support special requirements.
- The statewide infrastructure will provide open interfaces to support multi-protocol and multi-vendor environments. The SONET transmission backbone is an international standard that does not preclude the use of any vendor equipment for voice, video, or data transmission. Standards-based routing protocols will be used to connect remote agency equipment to the statewide data infrastructure. Future implementations of ATM standards will also continue the open environment connectivity arrangement.

Future enhancements to and developments on the statewide infrastructure will continue to promote the goals listed in this document and address the specific agency needs contemplated with them.

8. Policy Issues

Texas Government Strategic Plan for Telecommunications Services

A. Community-of-Interest Networks and the Need to Consolidate into a Single Network

The Telecommunications Planning Group (TPG) has been legislatively assigned the goal of planning a single consolidated statewide network. It is foreseen that a single network should support the telecommunications functions for all of state government and universities. Voice, video, and data traffic should use the same infrastructure. However, this may not always be feasible or in the best interests of the state.

Historically, state government functions differ by their respective legislative mandates. Each agency provides specific services and work within certain government communities. In many instances, the services of agencies overlap other government services. In others, agencies' responsibilities have little in common. Government services are usually grouped into the following areas, which also reflect legislative appropriations to some extent:

- *Criminal Justice*—including large agencies such as the Department of Public Safety and the Texas Department of Criminal Justice.
- *Health and Human Services*—including the Department of Human Services, Department of Health, etc.
- *Education/Higher Education*—including the Texas Education Agency, Texas Higher Education Board, and K–12.
- *General Government*—including administrative and regulatory agencies such as the Comptroller of Public Accounts and Railroad Commission.

The needs of these service groups vary depending on the application and service. Criminal justice agencies have high concerns for security and restricted access to the network. Human services deal constantly with confidentiality of data. Higher education has high bandwidth considerations to various points in the state, while K–12 education has more concerns on access to information, in general, and content of the information.

In considering the requirement to consolidate into a single infrastructure, the following areas need to be considered:

- The extent that the services overlap and the security and confidentiality needs of the agencies.

- The existing infrastructure of the agencies and the effect consolidation would have on the existing networks.
- The actual costs, if any, that the state would avoid and whether consolidation actually provides benefits.
- The technology required by the agencies to meet their service needs.
- Support requirements for legacy systems.
- Bandwidth and response time requirements that would affect design.

The TPG must continue to evaluate the need to reduce statewide costs in implementing a statewide infrastructure and the extent to which data networks will need to be consolidated.

B. Network Use Policy

It is state policy that the use of the TEX-AN network is restricted to official state business. This includes the use of voice services, video, and data networks. The state requires employees to reimburse the state for non-official use of the services. In addition, state policy requires that only official government entities can use the network. Exceptions are sometimes made for non-profit organizations or businesses contracted to perform services to the state. The growth of access to information through the state agency networks, the increased connectivity of local government and educational components, and the collapsing of all services into larger more robust networks, changes the current interpretation of previous policies.

The state needs to monitor network usage and examine existing policies and rules and update them appropriately. Additionally, the state infrastructure support for local and non-governmental entities needs to be reviewed to assure that privacy and confidentiality of information is maintained. DIR has adopted Standards Review and Recommendation Publications (SRRPUB) that address policy issues, recommended for agency adoption, related to personnel e-mail and Internet use on the state infrastructure. Additional SRRPUBs address policies for the implementation and content of agency web pages. However, these policies remain recommendation only and serve as guidelines, not rules, for agencies to adopt. DIR needs to continue to review and determine the need to implement actual rules binding on all agencies.

Issues related to network use policy that affect the statewide infrastructure, include, but are not limited to:

- Some agencies and local governments, including libraries and local school districts, are sharing the same data network infrastructure. The growth of information access of non-governmental entities to Internet sites may

affect business critical needs of some agencies needing to deliver information to remote network sites. This may be a critical issue and require the future development of community of interest networks that isolate the traffic requirements of priority sites and information.

- Policies for access to non-governmental Internet sites by employees need to be adopted by agencies in order to set the framework for the limitation of non-governmental use of access to information. Though the state does not encourage micro-monitoring of its employees, the use of valuable state resources needs to be balanced.
- The use of web sites throughout government for the dissemination of information encourages access by citizens to the platforms and adds to the bandwidth needs of the infrastructure. Security at the system platforms and monitoring of the bandwidth requirements are ongoing needs.
- Implementation of electronic commerce requires a closer relationship between suppliers, financial institutions, and government agencies. The need to eliminate the use of the state network by private industry may need to be relaxed to facilitate the implementation of business-oriented functions.

C. Support for Local Entities and Statewide Services

There is an expanding need to include network access support for local entities. State agency networks are being called on to support the exchange of information between local government components, whether as part of the government function, as a service, or by request from political subdivisions. The expanded service requirements increase bandwidth, support, and technical requirements of the statewide infrastructure.

The main drive behind this effort is the need for local government to access information and exchange data, including e-mail, on a local or regional basis. In most cases, local entities have no means to perform these activities and look to existing state connections as a means to accomplish these goals. Again, these connectivity requirements are driven by community of interest applications or services and are exemplified as follows:

- The need for local law enforcement agencies (police departments, sheriff offices, etc.) to exchange information in order to track or identify crime information. Local law enforcement is working with the Department of Public Services (DPS) in converting the legacy DPS network, TLETS

(Texas Law Enforcement Network), into a robust, high-bandwidth routable network.

- Statewide projects and grant programs managed by the Texas Education Agency, Texas State Library and the Telecommunications Infrastructure Fund Board (TIFB) have enabled school districts and libraries to build the local network infrastructures to support regional and Internet access. These local entities require an infrastructure to connect to statewide and national networks.
- University health science centers provide telemedicine services to hospitals, clinics, and regional community colleges, extending the centers networks to rural and remote areas around the state.
- The Office of Court Administration is working with the court systems in upgrading the court network infrastructures to enable the courts to connect to and receive information and services through state and national networks.

In general, these entities require cost-effective access for a large user group. As the technology and access is implemented for these sites, the technical support provided locally is not sufficient to meet the requirements and greater coordination and support is required from state agency network staffs.

D. Coordination of Access to State and Federal Funds

Several new programs, including the TIFB grant process within the state and the new national E-Rate program, provide funding avenues for implementing telecommunications infrastructures in schools and bringing technology to the classrooms. In a report presented to the TIFB by McKinsey & Co, Inc. (McKinsey Report), it was noted that there is not a coordinated effort within the state to manage access to state and federal grants and fund offerings. The issue identified in the McKinsey Report is even more pertinent as schools compete with each other for the funds and develop infrastructures without coordination on a statewide basis.

The issue remains, how can the state maximize the use of all available funding sources and should there be a central group assigned to deal with the issues below?

- There is a complex landscape of funding resources available for K–12 technology initiatives and programs (TIFB, E-Rate, literacy grants, etc.) and few sources to coordinate access to these grants. Districts are also

unable to see how to best take advantage of these multiple resources, since no clear direction has been provided.

- Without a clear understanding of the purpose of each funding resource—and how that purpose can be matched to a single state vision/plan for the use of telecommunications resources in K–12—the state is unable to fully leverage funding resources. (For example, a single state plan for the backbone network could be funded through the E-Rate. Other states have made such applications. Texas cannot, as it does not have a plan for such an infrastructure or a designated ongoing responsibility for operating such a network.)
- Without a clear and unified state plan for telecommunications access, the state cannot apply for federal E-Rate funding for the backbone network. Another consideration is whether the state could use internal grant resources to maintain the infrastructure developed through access to external sources.

The lack of coordination may inhibit the development of an infrastructure for the schools that will support long-range technology needs.

E. Agencies not Using the TEX-AN Network

All state agencies and universities are required by law to use TEX-AN services for their intercity telecommunications requirements. This allows GSC to plan and budget the network requirements for TEX-AN and to reduce state costs by buying bulk telecommunications services for the state. Additionally, smaller agencies can take advantage of the bulk procurements to purchase affordable services, no matter the location or amount of service required.

Some of the larger agencies are able to get rates lower than TEX-AN, because of the volume and location of the services needed by those agencies. Agencies with offices in metropolitan areas may have several options to procure telecommunications services at discounted rates, because telecommunications competition is heavier and services are cheaper in those areas. These agencies do not have to serve rural and remote areas and restrict the area to be served by contracts. Vendors often target such agencies with their cheaper service; a process referred to as “cherry picking.” However, the cherry-picking process erodes the TEX-AN user base and may reduce the overall state savings in telecommunications services.

Agencies do have a formal process to apply for waivers from the use of TEX-AN services. Agencies can request this waiver from GSC and DIR. The

waivers are approved or disproved based on the availability of the service, the cost of the service, and the larger impact on the total costs to the state. Even with the availability of this process, some agencies purchase services without consideration of the effect on the TEX-AN network.

GSC has limited resources to monitor agency compliance and has even less authority to maneuver agencies back to use of TEX-AN services. GSC normally works with agency executives by explaining the legislative requirements and issues, but this is a labor-intensive and time-consuming process and requires that GSC be aware of the noncompliance.

The state may need to review the authority of GSC to address noncompliance by agencies and the means to redress the situations.

F. Internet Address Space

As the State of Texas embarks upon implementing the legislation requiring an integrated network, it will be important that the state develop an overall plan for network address space utilization. Currently, each agency, university, and political subdivision obtains its own addresses with no central coordination and then places them on available state networks. This is similar to having each house in a community assign its own street name and number, and then have the municipality connect them all. The current system makes it difficult to reorganize agencies' networks to optimize the backbone without the painful re-addressing of every computer on the networks.

Since there are many protocols on the networks, each of which has its own addressing plan, it will be important for the state to decide which protocols will be supported on the backbone. One obvious answer is the Internet protocol TCP/IP, since this is the current backbone protocol for the State of Texas and the Internet community. A second protocol showing great promise, though not prevalent today, is the Asynchronous Transfer Mode (ATM) addressing scheme using the PNNI protocols. The TCP/IP networks today are well suited for data networks but have problems in adapting themselves to video and voice services. Once developed, ATM networks will work equally well for all three functions, but this requires another network addressing scheme to be deployed to allow the various state networks to integrate. Without this centralized planning, there will inevitably be costly re-addressing requirements necessary for network consolidation.

Additionally, there are various other protocols besides these two principal network protocols. Support for additional protocols on the state backbone networks is costly, complicated, and will reduce network reliability. Other

protocols, such as IPX, Decnet, and Appletalk, can be tunneled through existing TCP/IP networks.

Another issue soon facing the State of Texas is the transition from TCP/IP version 4 (IPV4) to TCP/IP version 6 (IPV6). IPV4 addressing uses only four bytes for the entire Internet community. Due to the address limitations and inadequate address assignments, IPV4 addresses are becoming scarce. The change to IPV6 will increase the address space to twelve bytes, allowing for a much larger number of addresses. A secondary advantage of IPV6 is that it incorporates a carrier header in the address that can easily change without requiring a complete network re-addressing. Currently most of the State of Texas is using addresses that are administered by one vendor. Under the current addressing scheme, any change of Internet service provider may require the re-addressing of hundreds of thousands of individual computers. While IPV6 deals with these issues, the transition from an existing network to a consolidated network will be more costly if not properly planned at the state level.

These types of issues can be resolved, but must be addressed from a statewide perspective. One possible solution is to create a central clearinghouse for all addresses for the State of Texas. This could be costly and would add administrative overhead to the network address acquisition process. A second approach would be the creation of a state group, similar in function to the national Internet Engineering Task Force (IETF) that administers such issues at the national level. This Texas IETF could be responsible for the following administrative issues:

- Recommendations for IPV6 migration
- Monitoring of State of Texas Internet traffic and development of growth statistics used in strategic planning
- Development of backbone routing plans
- Development of backbone costing algorithms

The Texas TIETF could also study general recommendations such as requiring that all state agencies, universities, and political subdivisions develop internal plans that incorporate non-registered network addresses behind some sort of address gateway. A DHCP gateway is one example of such a device. This has the dual advantage of allowing an easier migration to IPV6 for an agency network and allows that network to be moved without re-addressing to allow for backbone reconfigurations, as they may become necessary. Such studies would investigate any associated costs for re-addressing.

In order to ensure that network addressing issues are resolved, central coordination of address assignments is imperative.

G. Cost of the Network

Experience from two previous conversions of TEX-AN demonstrates that significant costs are incurred for installation of new facilities and the need to maintain two networks simultaneously, during the transition from one network to the next. The cost for converting from TEX-AN I to TEX-AN II was approximately \$5 million; from TEX-AN II to TEX-AN III, approximately \$10 million. TEX-AN is operated on a full cost-recovery basis using the Telecommunications Revolving Fund as the source of revenues to pay all network expenses. No funds were appropriated to GSC for the two previous conversions and in the case of TEX-AN III, severe cash flow problems caused payments to vendors to be delayed by more than six months.

Initial implementation of the backbone circuits for TEX-AN 2000 is planned for fiscal 1999. The greatest cost factor involved with moving to a new network backbone is the migration of the access circuits at customer locations. The migration is not expected to begin until 1999. Due to the network growth in the past four years and the demand for new services and applications, implementation costs for TEX-AN 2000 could easily reach \$25 million. Funding from the Legislature would alleviate the cash flow problems associated with the last transition, which occurred between September 1993 and February 1994.

Options for funding, including special legislative funding and special charges to agencies, among other scenarios, will need to be evaluated in providing for the transition to TEX-AN 2000.

H. Competition in Local Services

Currently, local telecommunications services are provided by a limited number of incumbent local exchange carriers (ILECs), with limited competition being provided by the new competitive local exchange carriers (CLECs). House Bill 2128 of the 74th Legislature²⁸ and the Federal Telecommunications Act of 1996²⁹ were intended to increase competition in the local exchange area by deregulating the Bell companies and allowing CLECs to enter the ILEC markets by reselling ILEC services or building new infrastructures.

The state may have options in the future to purchase bulk local services from various vendors. The state could contract for services from LATAs or arbitrary regional areas (metropolitan areas first, then rural regions, etc.). Contracts could be structured to procure services in a region at set rates, without regard to the remoteness or population in the areas. The state can leverage its purchasing powers to ensure service delivery for advanced technology at

reasonable rates. This would allow state agencies to purchase local services at set and predictable rates, through the TEX-AN Network, in order to better provide services to Texas citizens.

In order to implement bulk procurement in the local exchange arena, competition and service options need to be available. Competition has been slow in developing and is currently limited to metropolitan areas. It may be several years before true choice of local services is available. The state may need to pursue legislative and rule-making options to further enable the development of competition and may even be a driver in the facilitation of competition by contracting, as an anchor tenant, with CLECs.

As the deregulation and competition process develops, the state needs to investigate opportunities to contract for services and be an agent in facilitating this process.

I. Use of the State Right-of-Way to Install Telecommunications Facilities

Recent legislation allows the state to partner with private industry on the use of the state's right-of-way. Senate Bill 370 allows the Texas Department of Transportation (TxDOT) to enter into an exclusive agreement with a private telecommunications provider on the use of the right-of-way to install providers' equipment.³⁰ This can include:

- Telecommunications facilities within the right-of-way of a divided highway
- The use of telecommunications facilities owned or installed by TxDOT in or on the improved portion of a state highway including the median, structures, equipment, conduits or other components of the highway facility owned by the department

The partnership of the state with a private vendor on the use of the highway right-of-way may allow the state to take advantage of vendor-installed fiber, conduit, or facilities that can be used for the statewide network infrastructure. The state could request either fiber strands or bandwidth installed on the right-of-way for state use. As specified in Senate Bill 370, any such proposals would need to be coordinated by TxDOT.

TxDOT is still working on the administrative rules and issues related to such an implementation. TxDOT may enter into such an agreement if there is a clear benefit to TxDOT, such as resource-sharing opportunities or revenue enhancement. Additionally, fiber installation is a long-term process and the

state needs to consider the impact of owning or being responsible for the fiber in lieu of an outsourcing agreement.

Telecommunications facilities that may be installed on a right-of-way include, but are not limited to:

- fiber optics (long haul or intercity)
- coaxial cable
- radio, including cellular towers
- microwave towers

J. Network Security

One of the goals of government is to provide open access to state information. A means of accomplishing this is by the sharing of information across state networks and the Internet. In doing this, the state needs to remain aware of the issues with confidentiality of data and network security.

Open networks, by design, are constructed to allow access to information. Agencies must take the responsibility of protecting their individual systems from network intrusions and access to confidential information. The state has adopted guidelines for system and network security and requires each agency to ensure controls are in place to limit the access and use of information by authorized individuals only. However, national headlines regularly describe security breaches and hacker access to federal, state, and private systems.

The state, through the Information Resources Asset Protection Council (IRAPC), continues to investigate issues with security and information access. In building statewide infrastructures to provide citizen access to information and open exchange of data between governmental agencies, the state must balance the security needs of the network with open access to information. State information planners must work with the IRAPC to ensure guidelines and standards addressing state security issues are implemented by the agencies.

Continued areas of development to be considered for the statewide infrastructure include, but are not limited to implementations in the following areas:

- Data encryption
- Digital signatures and authentication
- Access controls and physical access limitations
- Network firewalls

The state must also prepare for actual security breaches and contingencies for such events.

Appendix 1

Texas Government Strategic Plan for Telecommunications Services

Telecommunications Planning Group Legislation

From Tex. Gov't. Code Ann. § 2054 (Vernon 1998).

SECTION 20. Chapter 2054, Government Code, is amended by adding Subchapter H to read as follows:

SUBCHAPTER H. TELECOMMUNICATIONS PLANNING GROUP

Sec. 2054.201. COMPOSITION.

- (a) The telecommunications planning group is composed of the comptroller, the executive director of the department [Department of Information Resources], and the executive director of the General Services Commission.
- (b) Each member of the group may designate an employee of the member's agency to serve in the member's place.

Sec. 2054.202. ADMINISTRATIVE PROVISIONS.

- (a) The telecommunications planning group shall post notice of its meetings in accordance with the open meetings law, Chapter 551, in the manner required for a state governmental body under that chapter.
- (b) The department [DIR] shall coordinate the staff and administrative support provided to the telecommunications planning group by the department [DIR], by the comptroller, and by the General Services Commission.
- (c) The telecommunications planning group may periodically elect one of its members to serve as presiding officer of the group.

Sec. 2054.203. TELECOMMUNICATIONS PLANNING AND POLICY.

- (a) The telecommunications planning group shall comprehensively collect and manage telecommunications network configuration information

about existing and planned telecommunications networks throughout state government.

- (b) The telecommunications planning group may require state agencies to submit to the group the agencies' network configuration information, but the group must use existing reports to gather the information if possible and minimize the reporting burden on agencies to the extent possible.
- (c) The telecommunications planning group shall establish plans and policies for a system of telecommunications services to be managed and operated by the General Services Commission.
- (d) The telecommunications planning group shall develop a statewide telecommunications operating plan for all state agencies. The plan shall implement a statewide network and include technical specifications that are binding on the General Services Commission.
- (e) The department [DIR] shall adopt appropriate policies and standards that govern the cost-effective and efficient management, operation, and use of state telecommunications services and shall distribute those policies and standards to all state agencies.
- (f) Each state agency shall comply with the rules, policies, standards, and guidelines the department [DIR] adopts under this section.

Sec. 2054.204. DEVELOPMENT OF PLAN FOR STATE TELECOMMUNICATIONS NETWORK.

- (a) The telecommunications planning group shall develop a plan for a state telecommunications network that will effectively and efficiently meet the long-term requirements of state government for voice, video, and computer communications, with the goal of achieving a single centralized telecommunications network for state government.
- (b) The plan must recognize that all state agencies, including institutions of higher education, are a single entity for purposes of purchasing and the determination of tariffs.
- (c) The plan must incorporate efficiencies obtained through the use of shared transmission services and open systems architecture as they become available, building on existing systems as appropriate. In developing the plan, the telecommunications planning group shall make use of the technical expertise of state agencies, including institutions of higher education.

Sec. 2054.205. DEVELOPMENT OF SYSTEM.

- (a) The telecommunications planning group shall develop functional requirements for a statewide system of telecommunications services for all state agencies. Existing networks, as configured on September 1, 1991, of institutions of higher education are exempt from the requirements.
- (b) The telecommunications planning group shall develop requests for information and proposals for a statewide system of telecommunications services for all state agencies.
- (c) The telecommunications planning group shall negotiate rates and execute contracts with telecommunications service providers for services. The telecommunications planning group may:
 - (1) acquire transmission facilities by purchase, lease, or lease-purchase in accordance with Chapters 2155-2158; and
 - (2) develop, establish, and maintain carrier systems necessary to the operation of the telecommunications system.

Sec. 2054.206. ADVISORY AGENCIES. The following state agencies shall formally advise the telecommunications planning group and send representatives to meetings of the group:

- (1) the Texas Education Agency;
- (2) the Texas Higher Education Coordinating Board;
- (3) The Texas A&M University System;
- (4) The University of Texas System;
- (5) the Telecommunications Infrastructure Fund Board; and
- (6) the Texas State Library and Archives Commission.

Sec. 2054.207. REPORT. The telecommunications planning group shall report biennially to the legislature not later than October 1 of each even-numbered year on the status of the current plan for a state telecommunications network and on the progress state government has made towards accomplishing the goals of the plan.

SECTION 21. Sections 2054.059, 2054.072, 2170.054, 2170.055, and 2170.060, Government Code, are repealed.

Appendix 2

Texas Government Strategic Plan for Telecommunications Services

Telecommunications Planning Group Strategic Plan Process

The Telecommunications Planning Group (TPG) has been legislatively mandated to develop a plan for implementing a consolidated network for all state agencies. This document outlines the process for completing the strategic plan. The goal is to open the process for input and comments from the public, vendors, and other agencies not directly involved in the TPG.

Schedule

This schedule outlines the time frames for completing the strategic plan. These dates are considered target dates for planning purposes. As the process continues, precise dates will be posted for TPG meetings.

August 15, 1997	Completion of draft outline for review by Advisory Agencies
August 29, 1997	First meeting of TPG staff and Advisory Agencies to review plan outline
September 25, 1997	Second meeting of Advisory Agencies to plan first TPG meeting
October 17, 1997	Complete assignments of strategic plan chapters/sections. First official TPG meeting.
December 1, 1997	Compilation of first set of draft papers and preparation of strategic plan initial draft
January (1st half) 1998	TPG staff and Advisory Agencies meeting to review first draft and plan second TPG meeting.
January (2nd half) 1998	Completion of rough first draft and second TPG meeting.
March 1998	TPG staff and Advisory Agencies meeting to complete second draft of plan and start agenda for third TPG meeting.
April–May 1998	Third TPG meeting and review of final plan draft.
Summer 1998	Completion and publication of plan. Completion of biennial Report to Legislature.

Advisory Agencies Meetings

The preceding schedule depicts time frames for meeting with the Advisory Agencies. An Advisory Agencies meeting will be held before each TPG meeting. Additional meetings will be called as needed to review task force findings, review draft documents, and handle other special cases. The goal of this process is to reduce the actual number of required meetings and to perform most of the work through electronic means.

Quarterly TPG Meetings

At this time, it is recommended that the TPG meet once every quarter to be updated on the following:

- Status of the strategic plan process
- Status of sub-committees created to deal with Internet addressing and the grant process
- New business

If required, additional meetings will be called by the TPG to address any other issues.

Delegation of Plan Sections

The draft outline for the plan will be distributed and a call for volunteers will be made to complete the sections. A list of the groups working on specific sections will be posted on the web. The first draft documents should be completed by December 1, 1997.

Web Site

A web site will be maintained for the TPG. The web site (<http://www.state.tx.us/TPG>) will be used to inform agencies and the public about TPG information. All staff and TPG meeting minutes will be posted. Draft documents will also be posted for public comment, after editing. E-mail addresses to TPG staff will be included for the forwarding of comments. Additionally, announcements of TPG meetings and agendas will be posted at this site.

TPG Mailing List

A mailing list has been created to provide for the exchange of comments and information related to the TPG. The mailing list is open to the public. Instructions for using the mailing list follow.

To Join the Mailing List

- 1) Send an e-mail to the following address (not case-sensitive):
tpg-request@lists.state.tx.us
- 2) Enter “**subscribe**” (without quotes) in the text section, not the subject line.
- 3) The TPG mailing list server will send a reply with text explaining the mailing list purpose.

To Unsubscribe

- 1) Send a message to **tpg-request@lists.state.tx.us**
- 2) Enter the following command in the body of the message: **unsubscribe**

You should receive a response notifying you of the successful completion of the command.

To Post Messages to the Mailing List

Send all discussion messages to: **tpg@lists.state.tx.us**

Messages sent to the **tpg-request@lists.state.tx.us** will be rejected.

Additional Commands

The mailing list server will respond to specific commands. All commands should be sent to the e-mail address (**tpg-request@lists.state.tx.us**), not posted to the message address above (**tpg@lists.state.tx.us**). The commands should be included in the text of the message.

Summary of Commands	
Which	Find out which lists you (or < address> if specified) are on
Who	Find out who is on the named < list>
Info	Retrieve the general introductory information for the named < list>
intro	Retrieve the introductory message sent to new users. Non-subscribers may not be able to retrieve this.
lists	Show the lists served by this Majordomo server
help	Retrieve this message
End	Stop processing commands (useful if your mailer adds a signature)

Glossary

Texas Government Strategic Plan for Telecommunications Services

ACD	Automated Call Distributor. Used in telephone systems to distribute calls equitably within a specific call group.
ATM	Asynchronous Transfer Mode. A cell-based, high-speed transmission protocol.
Backbone	The portion of the statewide network connecting different regions of the state and consolidating the transmissions of the agency networks.
Bandwidth	As used in this document, bandwidth refers to transmission capacity on telecommunications circuits (i.e., bandwidth on a T1 circuit is 1.544 Mbps).
B-ISDN	Broadband Integrated Services Digital Network.
CAPnet	The Capitol area FDDI network managed and operated by GSC. CAPnet supports state government connectivity in the Austin area.
CLEC	Competitive Local Exchange Carrier. A telecommunications carrier installing or reselling services in competition with the incumbent local exchange carrier.
CPA	Comptroller of Public Accounts.
DIR	Department of Information Resources.
DHCP gateway	Dynamic Host Configuration Protocol. A server that dynamically assigns IP addresses to nodes or workstations on a network, on device activation.
DS0	Digital Signal Zero. Signaling protocol and framing standard for a single T1 channel, one of 24 channels in a T1 circuit. Bandwidth for a DS0 is 64Kbps (clear channel).

DS1	Signaling protocol and framing standard for T1 circuits. A T1 circuit contains 24 DS0 channels and transmits 1.544 Mbps.
DS3	Signaling protocol and framing standard for a T3 circuit. A T3 circuit contains 26 T1 circuits and transmits approximately 45Mbps.
e-mail	Electronic mail.
E-Rate	Education rate. A Federal Communications Commission program for funding schools' and libraries' access to the Internet. Interstate telecommunications carriers fund the E-Rate.
FDDI	Fiber Distributed Digital Infrastructure. A fiber-based, 100 Mbps transmission system.
Frame relay	A digital, high-speed packet-switching protocol used to connect LANs to wide area networks.
FTE	Full-Time Equivalent employee.
Geosynchronous Orbit	Satellite orbit approximately 22,500 miles above the earth's equator. Due to the distance from the earth, the satellite seems to be stationary, relative to a point on earth.
GSC	General Services Commission.
H.320	ISO Standard for videoconference communications.
HHSCN	Health and Human Services Consolidated Network. The data network operated by the Department of Human Services to support the Texas health and human services agencies.
ILEC	Incumbent Local Exchange Carrier.
Internet II	University-based network, currently including more than 100 university sites, implemented for researching new Internet applications. Internet II is different from NGI in that NGI is a federally led and funded initiative.
IP	Internet Protocol.

IPV4 and IPV6	Internet Protocol Version 4 and Internet Protocol Version 6. IPV6 is the new protocol targeted to address limitations and other shortcomings with IPV4.
ISDN	Integrated Services Digital Network. A digital transmission protocol.
ISP	Internet Service Provider.
JCIT	Judicial Committee on Information Technology.
K-12	Kindergarten through 12th grade education.
LAN	Local Area Network.
LATA	Local Access and Transport Area.
LEO	Low Earth Orbit. Satellite orbit operating below approximately 1,000 kilometers.
List server	A workstation configured to act as an automated mailing list distribution system.
MVS	Multi-point Video Services. A service provided by Southwestern Bell Telephone for bridging a multi-site videoconference.
NCIC	National Crime Information Center.
NGI	Next Generation Internet. NGI is a multi-agency, federal research and development program to develop, test, and demonstrate advanced networking technologies and applications.
OC-1	(also OC-2, . . . OC-48) Optical Carrier 1. SONET bandwidth measurements, OC-1 is equal to approximately 51.8 Mbps. Each additional listing refers to a bandwidth multiple of 51 Mbps (the OC number multiplied by 51 Mbps).
PEIMS	Public Education Information Management System.
PNNI	Private Network to Network Interface. Routing information protocol used in ATM network implementations to connect multi-vendor equipment.
QOS	Quality of Service.

RESC	Regional Education Service Center.
RMICC	Records Management Information Coordinating Council.
TSEL	Texas State Electronic Library.
SDH	Synchronous Digital Hierarchy. The international standard for multi-megabit transmission hierarchy on fiber technology. The North American Standard is SONET, on which SDH is based.
Sesquinet	Regional university data network operated by Rice University for Internet access. Sesquinet is now part of a private partnership.
Shadow network	An independent logical network configured over the same wide area network used by other agencies. This allows for the sharing of the network hub equipment, but using different transmission bandwidth.
SONET	Synchronous Optical NETwork. A high-speed, fiber-optic-based standard for multi-megabit transmission hierarchy in North America.
SRRPUB	Standards Review and Recommendation Publication. Guidelines published by DIR for agencies to use in planning their information resource implementations.
State Agency	A Texas state agency or state-supported university.
T1	A digital transmission circuit consisting of 24 64Kbps channels.
T3	A digital transmission circuit consisting of 28 T1 circuits.
TCP/IP	Transmission Control Protocol/Internet Protocol.
Telemedicine	The use of videoconferencing or other telecommunications technology for medical consultations or education.
TETN	Texas Education Telecommunications Network.
TEX-AN	TEXas Agency Network. The statewide network managed by GSC. All agencies are required to use TEX-AN to the fullest extent possible for all intercity communications.

Texas Government	All government entities in Texas, including state government agencies and universities.
THEnet	Texas Higher Education Network.
TLETS	Texas Law Enforcement Telecommunication System.
TPG	Telecommunications Planning Group.
TRM	Transmission Resource Manager.
T-STAR	Texas School Telecommunications Access Resource.
TVRO	Television Receive-Only. Ground satellite equipment (dish).
vBNS	Very high speed Broadband Network Services. vBNS is a nationwide research network project jointly operated by MCI and the National Science Foundation targeted for supporting high-performance, high-bandwidth research applications.
VidNet	Statewide video network operated by GSC. VidNet uses ISDN-based technology for transmission.
WAN	Wide Area Network.
X.500	ISO standard. The X.500 Directory is a collection of systems for defining logical database information sets.

Notes

- ¹ Tex. Gov't Code Ann. § 2054.204 (Vernon 1998).
- ² Tex. Gov't Code Ann. § 2054 (Vernon 1998).
- ³ Texas Comptroller of Public Accounts. *Breaking the Mold: New Ways to Govern Texas*, Texas Performance Review, Austin 1991.
<http://www.window.state.tx.us/tp/btm/btmhome.html> (24 September 1998).
- ⁴ Telecommunications Planning Group. *Texas Telecommunications Strategic Plan (TTSP)*, Austin 1994.
<http://www.dir.state.tx.us/oops/telesp.txt> (24 September 1998).
- ⁵ Texas Department of Information Resources. *A Vision for the Millennium: 1997 State Strategic Plan for Information Resources Management*, Austin 1997.
<http://www.dir.state.tx.us/DIR/vision.htm> (24 September 1998).
- ⁶ Texas Department of Information Resources. *Meeting Citizens' Needs: A Vision for Information and Technologies to Serve Tomorrow's Texans*. State Strategic Plan for Information Resources Management. Austin 1993.
- ⁷ Texas Department of Information Resources. *Facing the Future: A Vision for Information and Technologies to Serve Tomorrow's Texans*. State Strategic Plan for Information Resources Management. Austin, 1995.
<http://www.state.tx.us/DIR/ssp95.html> (24 September 1998).
Texas Department of Information Resources. *A Vision for the Millennium: 1997 State Strategic Plan for Information Resources Management*. Austin 1997.
<http://www.state.tx.us/DIR/vision.htm> (24 September 1998).
- ⁸ Telecommunications Planning Group. *Statewide Telecommunications Network Plan*. Austin, 1991.
- ⁹ See Note 4.
- ¹⁰ Tex. Gov't. Code Ann. §551.002 (Vernon 1998).
- ¹¹ Tex. Gov't. Code Ann. § 552.021 (Vernon 1998).
- ¹² Tex. Gov't Code Ann. § 441.203 (Vernon 1998).
- ¹³ Texas Department of Education. *Long Range Plan for Technology of the State Board of Education, 1988-2000*, Austin, 1988.
- ¹⁴ Texas Department of Education. *Long-Range Plan for Technology, 1996-2010*, Austin, 1998.
<http://www.tea.state.tx.us/technology/lrpt/index.html> (24 September 1998).
- ¹⁵ Tex. Utilities Code Ann. § 57 (Vernon 1998).
- ¹⁶ Texas Commission on Judicial Efficiency. *Governance of the Texas Judiciary: Independence and Accountability, 1996-1997*, Austin 1996.
<http://www.courts.state.tx.us/jcit/ittftc.htm> (24 September 1998).
- ¹⁷ Tex. Transp. Code Ann. § 223.013 (Vernon 1998).
- ¹⁸ Tex. Bus. & Com. Code Ann. § 2.108 (Vernon 1998).
- ¹⁹ Tex. Gov't Code Ann. § 2177.001 (Vernon 1998).
- ²⁰ See Note 6.
- ²¹ See Note 4.
- ²² See Note 1.
- ²³ 1 TAC § 201.13
- ²⁴ 1 TAC § 201.16
- ²⁵ See Note 8.
- ²⁶ Texas Department of Information Resources. *Directory and Locator Services*, Standards Review and Recommendation Publication SRRPUB08, Austin 1995.
<http://www.state.tx.us/Standards/srrpub08.htm> (24 September 1998).
- ²⁷ See Note 6.
- ²⁸ See Note 16.
- ²⁹ U.S. Public Law 104-104. 104th Cong., 2nd sess., 2 August 1996. *Telecommunications Act of 1996*.
- ³⁰ See Note 18.